INSTRUCTION MANUAL

SYSTEM 716
BRICKWALL™ FILTER

WAVETEK

WAVETEK SAN DIEGO, INC.

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MP MASTER

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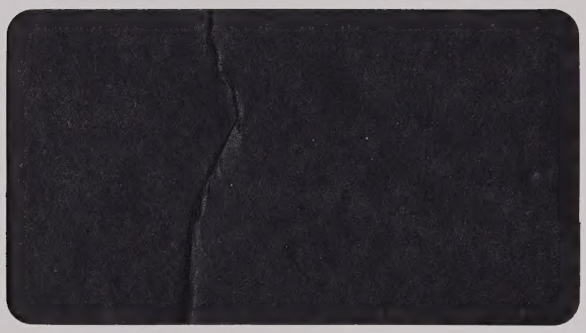

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SAFETY FIRST

Protect yourself. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with ⏚ or ⚠).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.

SECTION 1
INTRODUCTION

1-1. THE SYSTEM 716 BRICKWALL™ FILTER

Each System 716 Brickwall™ Filter is a wide-range, tunable, and remotely programmable filter with near-ideal passband and stopband characteristics. The Filter system consists of 16 filter channels which may be used independently, or cascaded in series. Each channel can be either a low-pass (716-01) or high-pass filter (716-02) which exhibits a nearly flat passband, yet provides a rolloff rate of better than 115 dB per octave; in cascade, the two identical channels offer the exceptionally high rolloff rate of 230 dB per octave.

The System 716 consists of a mainframe with front panel controls; an IEEE-488/1978 interface and as many filter cards as ordered up to a maximum of 16.

Each channel consists of a 7th-order (7 poles and 6 zeroes) Elliptic (Cauer) filter with design values of 0.3 dB peak-to-peak passband ripple, and 85 dB stopband attenuation above 1.7 x cutoff frequency for a low-pass channel and below 0.6 x cutoff frequency for a high-pass channel.

The cutoff frequency may be manually set from 10 Hz to 99 KHz with 2-digit resolution and 1 Hz to 9 Hz with 1-digit resolution. Pre-and post-filter gain may be selected up to 40 dB and 20 dB, respectively, in 10 dB steps. Overload indicators are also provided to ensure that signals being processed are at the optimum levels. The System 716 also offers programming of cutoff frequency and gain by digital programming through an IEEE-488/1978 Interface. Under remote control the cutoff frequency range may be set from 1 Hz to 100 KHz.

Program storage for up to 16 different filter cutoff frequency and gain settings for each filter is provided. The data is stored in a memory supported by battery back-up.

One important application of these filters is as an anti-aliasing filter in data acquisition for analysis by a digital computing system. Band-limiting the data prior to sampling by an analog-to-digital converter is necessary to prevent "aliasing" of out-of-band components into the frequency band of interest. As the sampling frequency is changed, the cutoff frequency of the filter can be programmed automatically to a corresponding value (typically less than half the sampling frequency), to obtain optimum out-of-band signal rejection. With these advanced filters, sampling rates can be as low as 2.7 x signal bandwidth and still achieve greater than 80 dB attenuation of aliased components.

1.1.1 Options

No options are available.

1.1.2 Accessories

Operating manual and rack mounting kit are supplied.

1-2. SPECIFICATIONS

In order to clarify some specifications it is necessary to provide definitions of the commonly used terms for Elliptic filters.

The low-pass characteristic of an Elliptic filter is illustrated in Fig. 1.1. The high-pass characteristic is the "mirror image" of the low-pass curve.

The Cutoff Frequency, F_c, is the frequency at which the response of the filter drops below the specified passband ripple, A_{max}. The conventional -3 dB frequency criterion has no significance in an Elliptic filter.

For the low-pass section, F_s , is the lowest frequency for which the specified stopband attenuation (A_{min}) applies. For the high-pass section, it is the highest frequency.

The low-pass and high-pass cutoff frequency tolerances of the 716 filter are intentionally "skewed" to beyond their nominal values. That is, the high-pass cutoff frequency is slightly lower and the low-pass cutoff frequency is slightly higher than its nominal value. This ensures that when the two sections are set to identical cutoff frequencies (minimum bandwidth) the slopes of the resulting response will not overlap and cause a passband amplitude loss ("tenting").

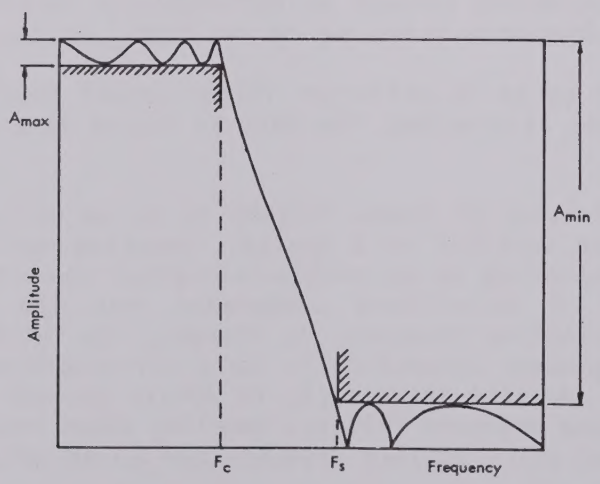


Fig. 1.1. Elliptic Filter Response

1.2.1. System 716-01 & 716-02 Filter Card

FUNCTIONS:	Low-pass (716-01) or High-pass (716-02); rolloffs of 115 dB/octave and individually tunable cutoff frequencies.
Cutoff Frequency Range: (High-pass and Low-Pass)	1 Hz - 99 KHz under local control; 1 Hz - 100 KHz under remote control.
Programming and Resolution:	Two 10-position switches and one 4-position multiplier switch.

Multiplier	Frequency	Resolution
X1	1-99Hz	1Hz
X10	10-990Hz	10Hz
X100	100-9.9KHz	100Hz
X1K	1K-99KHz	1KHz

Accuracy:	High Pass Filter; +0%,-3.5% max. Low Pass Filter; -0%,+3.5 max.
Stability:	±200 ppm/°C
GAIN:	
Pre-filter Gain:	0, +10, +20, +30, +40 dB. Manually set by one 5-position switch or remotely via IEEE-488/1978 interface.
Post-filter Gain:	0, +10, +20 dB. Manually set by one 3-position switch or remotely via IEEE-488/1978 Interface.
Gain Accuracy:	±0.25 dB
INPUT CHARACTERISTICS:	
Impedance:	1 Megaohm, 50 pf, nominal
Full-Scale Signal:	± 10 Volts @ 0 dB gain; divide by gain for other than 0 dB gain settings
Absolute Max. Input:	± 100 Volts
Passband Ripple:	0.8 dB, p-p max (1.4 dB p-p max. for high pass filter when F_C > 40 kHz.)
Stopband Attenuation:	80 dB, min. for F > 2 F_C (Low Pass), F < 0.5 F_C (High Pass).
F_S/F_C Ratio (Fig. 1.1):	1.7 low-pass 0.6 high-pass
Amplifier Cutoff:	-3 dB at approximately 400 kHz.

OUTPUT CHARACTERISTICS:

Impedance:	50 Ohms, nominal
Full-Scale Signal:	± 10 Volts into load resistance >5K Ohm
Noise with respect to Output at any Gain Setting:	110 dB / $\sqrt{Hz}$ below full-scale above 50 Hz
Harmonic Components (1KHz Input Frequency):	> 80 dB below full-scale
Intermodulation Products: (Input frequencies of 70 KHz and 90 KHz)	> 70 dB below full-scale
DC Offset:	Adjustable to 0 Volts
Drift (@ 0 dB gain):	± 50 mV, +15° to +40°C
Crosstalk between channels (Input Source 50 Ohms or less):	85 dB below full-scale at output
Line-Related or Spurious Components (Input Source 50 Ohms or less):	80 dB below full-scale
Phase Match Between Channels:	
Low Pass;	±3° max dc to 0.8 f_c,
	±4° max 0.8 f_c to f_c.
High Pass;	±3° max 1.3 f_c to 130 kHz,
	±4° max f_c to 1.3 f_c.
Amplitude Match Between Channels:	
Low Pass;	±0.3 dB max dc to 0.8 f_c,
	±0.5 dB max 0.8 f_c to f_c.
High Pass;	±0.3 dB max 1.3 f_c to 130 kHz,
	±0.5 dB max f_c to 1.3 f_c.

1.2.2 System 716-11 Mainframe

Memory:	Sixteen selectable groups; each group has storage for 16 channel settings.
Battery back-up for memory:	Trickle charged, when unit is powered. 1000 hours nominal back-up with a low battery LED indicator.
Display:	Seven-segment displays for: Group Number Channel Number Pre-filter Gain Post-filter Gain Cutoff Frequency

Channel Characteristic:	LED for High-pass or Low-pass indication
Overload Indicators:	Two LED's, one for filter input and one for filter output.
Overload Modes:	Two Overload Modes can be selected; one Mode monitors the input and output of each selected channels; the other Mode monitors all channels and indicates which one is overloading.
Input/Output Connectors:	BNC's on rear panel
Remote Programming/Sensing:	IEEE-488/1978 Digital Interface
Power Requirements:	115/230 Volts AC ±10%, 48-400 Hz, 150 watts max., less than 1.2 watts per channel
Operating Temperature:	0°C to 40°C
Storage Temperature:	-20°C to 50°C
Dimensions:	8 3/4 "H x 17" W x 21"D. (22.2cm x 43.2cm x 53.4cm)
Accessories Supplied:	Operating Manual, Rack Mounting Kit
Self Test Diagnostics:	Microprocessor checks unit on power up; failure mode indicated on seven segment displays.

SECTION 2
INITIAL PREPARATION

2-1. INSPECTION

The instrument is electrically operational as shipped from the factory. It was carefully inspected and tested prior to shipment and operated for a number of hours to reduce the probability of early failure. After unpacking the unit, inspect it carefully for shipping damage. Check especially for broken controls and connectors, and dented or scratched cabinet parts. Should the instrument show any signs of damage, file a claim with the carrier immediately. Preserve the carton and packing materials; they will be required by the carrier.

It is recommended that conformance to specifications be verified upon receipt. In case of discrepancies, refer to the warranty at the beginning of this manual.

2-2. INSTALLATION AND POWER REQUIREMENTS

The System 716 is designed for table-top operation or installation in a standard 19-inch RETMA rack. A standard Chassis Trak drawer slide Model number, C300S-122, may be installed into the existing PEM nuts on each side panel. Ambient temperature within the rack must not exceed 40°C while the instrument is operating. Other paragraphs in this section describe connections and switch settings which should be made before the unit is installed.

CAUTION

ALWAYS ENSURE THAT THE 115/230 VOLT SWITCH IS SET FOR THE NOMINAL LINE VOLTAGE AND THAT A FUSE OF THE PROPER RATING IS INSTALLED IN THE INSTRUMENT. IF THE SWITCH IS SET INCORRECTLY OR A FUSE OF THE WRONG RATING IS USED, THE INSTRUMENT MAY BE DAMAGED OR FAIL TO OPERATE.

The instrument will operate from either 115 or 230 volts ac $\pm$10%, 48-400 Hz. Conversion for line voltage is performed with a slide switch mounted on the rear panel (see Fig. 3.1). The unit is shipped with the switch set for 115 volts. To change the setting, insert a small-blade screwdriver in the switch slot and move switch to expose 115 for 115 Vac operation, or 230 for 230 Vac operation.

The instrument is shipped with a 3 amp slow-blow fuse for 115-volt. A 1.5 amp slow-blow fuse is to be used for 230-volt operation.

WARNING

IN KEEPING WITH STANDARD SAFETY PRACTICE, THE CASE OF THE INSTRUMENT IS GROUNDED THROUGH THE POWER CORD. IF THE INSTRUMENT MUST BE CONNECTED TO A TWO-WIRE RECEPTACLE, USE A PARALLEL-GROUND ADAPTER AND CONNECT THE SHORT LEAD TO GROUND.

2.2.1 Filter Input Grounding Precautions and Line Frequency Pickup

The 716 Filter system has great amplification capacity. The 40 dB input gain and 80 dB filter range allow the processing of low level signals. Some low level signals however, can pass from the ac power line through the instrument connected to the filter input. These signals can be low frequency (60 Hz or its harmonics) or noise from other instruments connected to the same power distribution system. Even when the instrument connected to the filter input has an "AC Line Filter", most of them have poor rejection for frequencies below 500 KHz.

If low level signals from the ac power line appear to be a problem, then it is recommended to isolate the ground following the caution below. Many instruments have switches that "Isolate or Float" the chassis ground of the instrument. However, care should be exercised in floating instruments that do not have this provision. If the instrument or the AC outlets are improperly wired and the chassis is "Floated" off ground, a high voltage could exist between instrument cases. These connections should be thoroughly checked before applying power in these applications.

Caution must also be taken to avoid mounting another instrument on or near the System 716 to avoid line frequency pickup. The effect will be determined by the radiated field from the other instrument's transformer. Some instruments can degrade the line frequency by as much as 20 dB depending on the size of its transformer and its shielding.

SECTION 3
CONTROLS AND CONNECTORS

3-1. INTRODUCTION

Prior to using this instrument the user must become familiar with the front and rear panel controls discussed below.

Front panel controls shown in Fig. 3.1a will be described. Then a description of the rear panel controls and connectors, shown in Fig. 3.1b, will be given.

3.1.1 Memory Section (Fig. 3.1a)

A LED readout (1) shows the group number that can be incremented or decremented with HOLD TO SCAN Momentary Switches (2). There are sixteen groups numbered one through sixteen. Each memory group stores the pre-filter gain, filter cutoff frequency and post-filter gain settings of sixteen independent filter channels.

The Memory Section also includes three momentary push buttons: the HOLD TO VIEW MEMORY button (3) must be held to view the pre-filter gain, post-filter gain, and cutoff frequency settings that are stored in memory corresponding to the selected channel. When not held, the settings present in each channel are displayed. The remaining two switches, STORE FROM CHANNEL (4) and LOAD TO CHANNEL (5) are used to transfer settings to and from memory and the selected channel or channels.

Settings that are stored in memory are retained by battery backup. NICAD batteries are recharged whenever power is on and will last approximately one thousand hours depending on charge duration, temperature, battery life, etc. BAT POWER LOW LED (6) flashes when the battery voltage drops below a preset threshold and will flash at about a two second rate for a few hours until the battery is depleted. A deep discharge of the batteries is shown upon power turn on; the battery low light will flash several minutes until the charge threshold voltage is reached.

3.1.2 Channel Section (Fig. 3.1a)

A LED readout (7) shows the channel number that is selected by the two HOLD TO SCAN buttons (8). These switches are used to increment or decrement the readout.

There are sixteen channels numbered one through sixteen. The position of the card in the card cage is assigned a channel number and any card inserted in the slot assumes that channel number. Each card contains a register for holding the settings of gain and cutoff frequency and a latch that can store overload status.

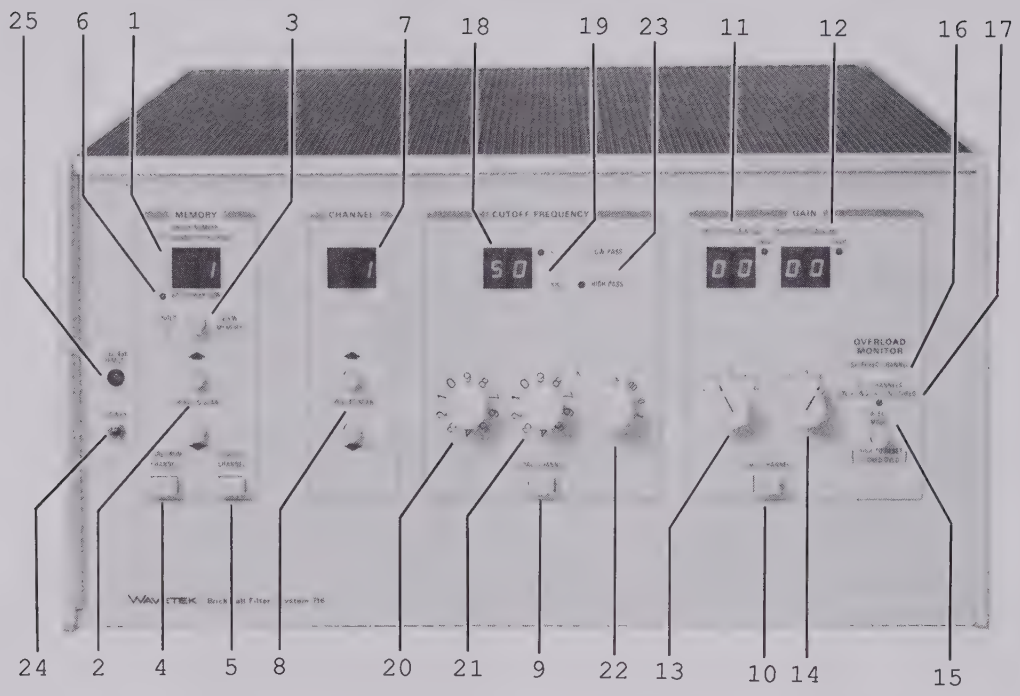


Fig. 3.1a. Front Panel

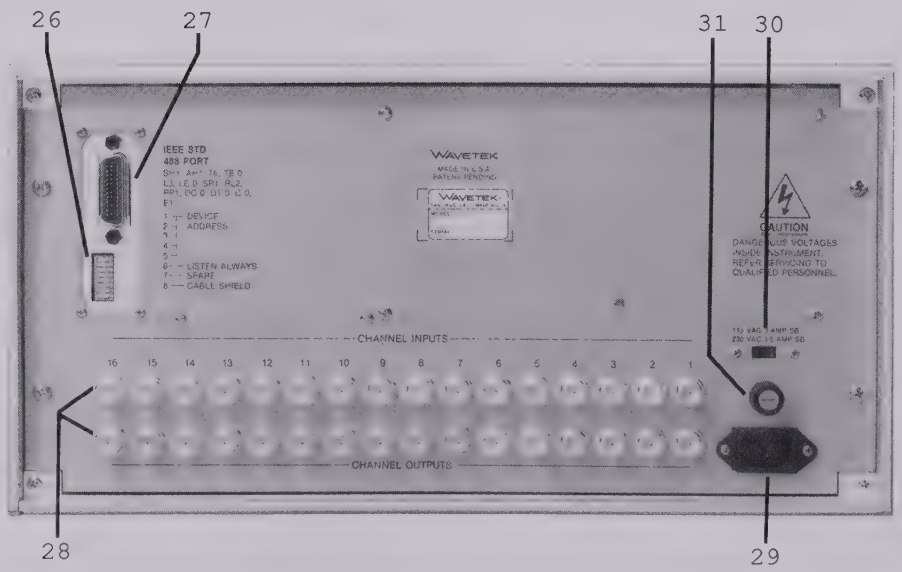


Fig. 3.1b. Rear Panel

Settings can be transferred from Memory to a channel and vice versa. For example if CHANNEL NUMBER (7) shows 11, then pressing STORE FROM CHANNEL (4) will transfer the gain and frequency settings of the filter card in channel 11 to the MEMORY GROUP NUMBER (1) shown. If it is desired to transfer the settings of all sixteen channels into the Memory Group, the STORE FROM CHANNEL (4) button and one of the CHANNEL HOLD TO SCAN (8) buttons must be depressed TOGETHER until the channel LED DISPLAY increments through all channel numbers. Similarly, an entire Memory Group can be moved into the channels by simultaneously depressing the LOAD TO CHANNEL (5) and one of the CHANNEL HOLD TO SCAN (8) buttons.

If it is desired to set either the same front panel gain or cutoff frequency settings to all channels then CHANNEL HOLD TO SCAN (8) button is pressed while holding LOAD CHANNEL corresponding to the setting to be loaded, i.e. (10) for GAIN or (9) for CUTOFF FREQUENCY. Both buttons are held until all the channel numbers have been scanned. If both gain and frequency settings are to be transferred to all channels, then it must be done sequentially. For example, while pressing CHANNEL HOLD TO SCAN (8), press CUTOFF FREQUENCY LOAD CHANNEL (9), until all channels are scanned and then press GAIN LOAD CHANNEL (10) ,until all channels are scanned.

3.1.3 Gain Section (Fig. 3.1a)

A LED readout display shows the PRE-FILTER (11) and POST-FILTER GAIN (12) settings stored for the channel that is displayed. This information can be displayed for each channel as selected by the CHANNEL HOLD TO SCAN (8) buttons. For any channel selected (7), the gain setting can be modified by adjusting the pre-and post-gain rotary switches (13) (14) and depressing the GAIN LOAD CHANNEL (10) button. The readouts (11) and/or (12) will now display the new information transferred to the channel selected. If it is desired to set the gains of all the channels to the rotary switch setting, then the LOAD TO CHANNEL (10) and one of the CHANNEL HOLD TO SCAN buttons should be depressed TOGETHER. The CHANNEL NUMBER readout (7) must be incremented through all channels to store the information in all channels.

The OVERLOAD MONITOR section contains a momentary button that selects the overload test mode. There are two modes of test that can be selected and are indicated by a LED light. One of the two modes is always active. The SELECTED CHANNEL (16) mode is normally used for setting the gains of the channel displayed under CHANNEL NUMBER (7) . There is an overload light for the input of the filter, (11) , and one for the output (12) . If an overload occurs momentarily, the appropriate LED will light and extinguish in about one tenth of a second - long enough for the eye to follow a fast overload status. Overload as short as 10 microseconds will be detected. A constant overload will keep the LED on until the condition disappears.

The other overload test mode is the ALL CHANNELS (17) mode which is normally used during system operation. In this mode, an overload must last for about 100 milliseconds to be detected. If an overload does occur in

any channel, it is stored and the CHANNEL NUMBER readout (7) automatically starts incrementing. It stops at the first channel whose overload latch has been set. This identifies the offending channel. Pushing the CHANNEL HOLD TO SCAN (8) will cause another automatic scan until another overloaded channel is found. The overload latches are reset by pressing the SELECT MODE (15) button which will also cause the OVERLOAD MONITOR MODE to change to the SELECTED CHANNEL (16) mode. If the "SELECTED CHANNEL" mode has been in effect for more than about four seconds, an invalid overload condition will be indicated when switching to "ALL CHANNELS" mode. To eliminate this invalid condition, return to "SELECTED CHANNEL", then select "ALL CHANNELS" mode within a time span of four seconds.

3.1.4 Cutoff Frequency Section (Fig. 3.1a)

LED readouts (18) and (19) display the active cutoff frequency stored in the channel. Any of the sixteen channels can be displayed by changing the CHANNEL NUMBER (7) with either CHANNEL HOLD TO SCAN button. The LED display is organized as two digits (18) with a decimal point in front of each and two separate LED indicators to indicate Hz or KHz (19). Channel data can be modified by setting the three rotary switches (20) (21) and (22) on the panel to the desired setting and depressing the LOAD CHANNEL button (9) in this section. The CUTOFF FREQUENCY readout (18) will now display the new information transferred to the selected channel. If it is desired to set the same cutoff frequency for all channels to the rotary switch setting, then the CUTOFF FREQUENCY LOAD CHANNEL (9) and the CHANNEL HOLD TO SCAN (8) buttons should be depressed TOGETHER. The CHANNEL NUMBER LED readout (7) must be incremented through all the channels to store the switch settings.

Also in the cutoff frequency section are two LED's that indicate which filter characteristic, High Pass or Low Pass (23), is present. If no card is present in the displayed channel, both indicators and readout will be off. The gain readouts will display an "E" when no filter card is present.

3.1.5 Power Switch (Fig. 3.1a)

Power switch (24) is provided to apply mains power to the unit.

3.1.6 IEEE-488 Remote LED (Fig. 3.1a)

Indicator (25) is affiliated with IEEE STD 488 BUS INTERFACE. The remote light indicates that front panel control is completely under the control of the IEEE 488 INTERFACE BUS and that data transfers to or from the IEEE 488 BUS may be in progress.

All front panel, memory and channel settings can be sensed and controlled by the interface bus. Overload status can also be sensed.

3.1.7 Device Address Code Selection - Switches #1 through #5 (26) (Fig. 3.1b)

The five top-most switches on the rear panel switch assembly allow the selection of the device address in the system. The range of addresses is from 0 to 30 (decimal) corresponding to the ASCII characters "SPACE" through ">".

The switches have binary weights of "1", "2", "4", "8", and "16" starting with switch #1. When the right edge of the rocker is depressed, the binary weight of that switch contributes to the address. When the left edge of the rocker is depressed, that weight is off. For example, to set an address of 11 (decimal), the rocker switch pattern would be (top to bottom) depressed right, right, left, right, left.

3.1.8 Listen Always (Addressed Always) Mode-Switch #6 (Fig. 3.1b)

The LISTEN ALWAYS mode allows the System 716 to behave as only a listener which is always addressed. This eliminates the necessity for explicitly addressing the unit in simpler test systems. When the LISTEN ALWAYS rocker switch is depressed towards the right the LISTEN ALWAYS mode is selected. When this rocker switch is depressed left the unit must be explicitly addressed to receive or transmit data.

The LISTEN ALWAYS switch is also used to bypass diagnostics that are performed upon power turn on. As a result, it is suggested that the switch be depressed left during power turn on and only after power up and diagnostics have been completed should it be depressed right. Completion of diagnostics is indicated when the remote light extinguishes and 50 KHz cutoff frequency has been programmed in each channel.

3.1.9 Cable Shield - Switch #8 (Fig. 3.1b)

When this switch is depressed right, the shield of the IEEE BUS cable is electrically connected to the circuit ground of the System 716. When the switch is depressed left, the shield is not connected to the System 716.

Use of this switch may be necessary in achieving optimum noise performance in a multi-instrument system.

3.1.10 Miscellaneous (Fig. 3.1b)

The other controls and connectors on the rear panel are obvious and will be quickly reviewed.

A 24-pin connector (27) corresponding to the IEEE 488 standards is used for remote control.

The input and output to each filter card is through BNC's (28) with their grounds isolated from the chassis.

Power is applied through a standard 3 wire connector (29) with the case of the instrument grounded through one pin.

The AC power voltage is selected by the switch, item (30) . It requires a screw driver to change settings.

The fuse is mounted in a fuse holder, item (31) .

3-2. OPERATING PROCEDURES

3.2.1 Cutoff Frequency

The cutoff frequency is defined by the two cutoff frequency dials and the multiplier. Always select the minimum multiplier setting. For example, a cutoff frequency of 90 Hz can be set as 9 x 10 or 90 x 1. The best choice is 90 x 1.

3.2.2 Pre-filter Gain

The passband gain of each channel at its input may be selected to be 0, 10, 20, 30 or 40 dB using the GAIN switch. To maximize the useful dynamic range, the maximum gain should be used without causing the overload LED (OVLD) to light. OVLD on indicates that the input signal has exceeded the maximum amplitude for linear operation. If the signal exceeds this range, spurious signals, such as intermodulation products and harmonics, will be generated.

The maximum desirable full-scale input signal is ± 10V (7.1 V rms) for 0 dB gain. When gain is employed, the maximum input signal decreases in direct proportion to the increase in gain. For example, with 20 dB gain, the maximum desirable input amplitude is ± 1.0V (0.71 V rms).

CAUTION

INPUT SIGNALS IN EXCESS OF ± 100V IN ANY GAIN SETTING MAY DAMAGE THE INSTRUMENT.

3.2.3 Post-filter Gain

Post-filter gain in most applications should be set to 0 dB. To increase the signal level through the filter, pre-filter gain should be used to maximize the useful dynamic range. There are however, circumstances when using post-filter gain is desirable.

If the signals within the filter passband are low, but there are larger out of band signals, pre-filter gain setting is determined by the larger out of band signals so that circuits do no overload. Output gain is then available to increase the in-band filtered signals to usable levels. Output gain should be increased with care so that post-filter overload does not occur. The output overload is set to go on if the output signal exceeds ± 10 volts.

3.2.4 Cascading Channels

A number of channels may be cascaded by connecting the output of one channel to the input of another to either increase the rolloff of a high pass or low pass filter, or to construct a band pass filter.

For example, cascading two identical low pass filter channels will double the rolloff. The cutoff frequency of both channels should be set to the same value. When using the gain controls, the gain setting of the first channel should be maximized before using the gain controls of the second channel. For example, if 50 dB gain is needed, set the first channel to 40 dB and the second to 10 dB.

A band pass filter is constructed by cascading first a high pass filter followed by a low pass filter. The passband extends from the high pass cutoff frequency setting to the low pass cutoff frequency setting. Note, the cutoff frequency for the high pass filter is a lower numeric value than the cutoff frequency for the low pass filter.

The narrowest passband is obtained by setting high pass and low pass cutoff frequencies to the same value f_0. In this case, the insertion loss is nominally 0 dB; the 3 dB bandwidth extends from approximately 0.95 f_0 to approximately 1.05 f_0 and it is equal to 0.1 f_0. This corresponds to a Q of nominally 10 and a 60/3 - dB shape factor nominally 11. In this mode of operation, the instrument operates as a constant -Q, or constant % - bandwidth filter.

The following Figures show the typical filter responses available.

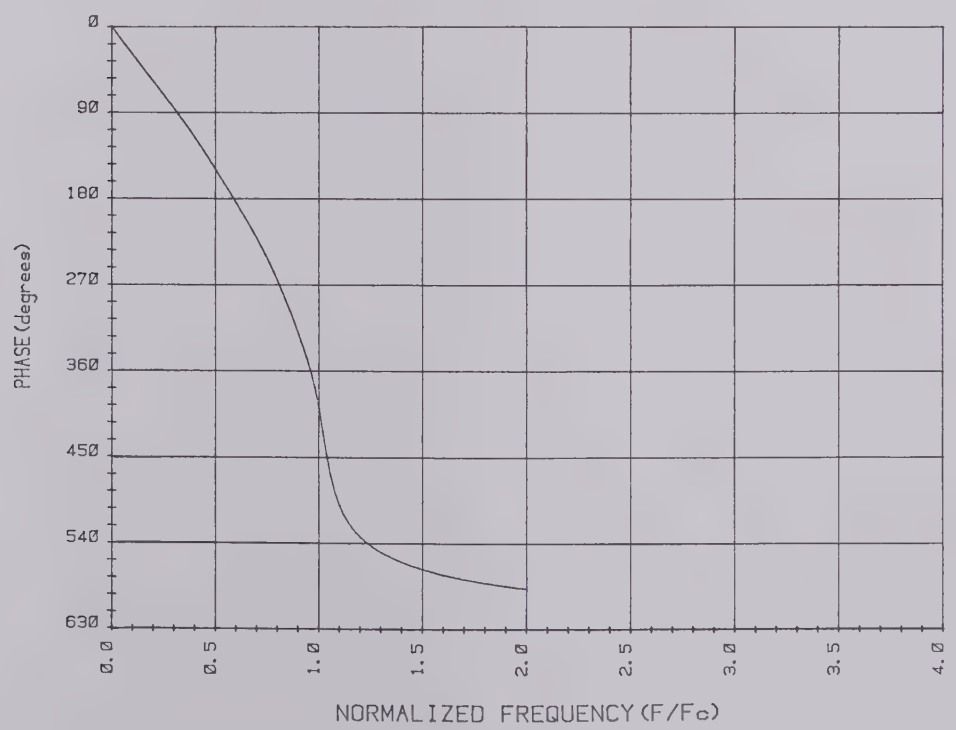


Fig. 3.3. Nominal Phase Response

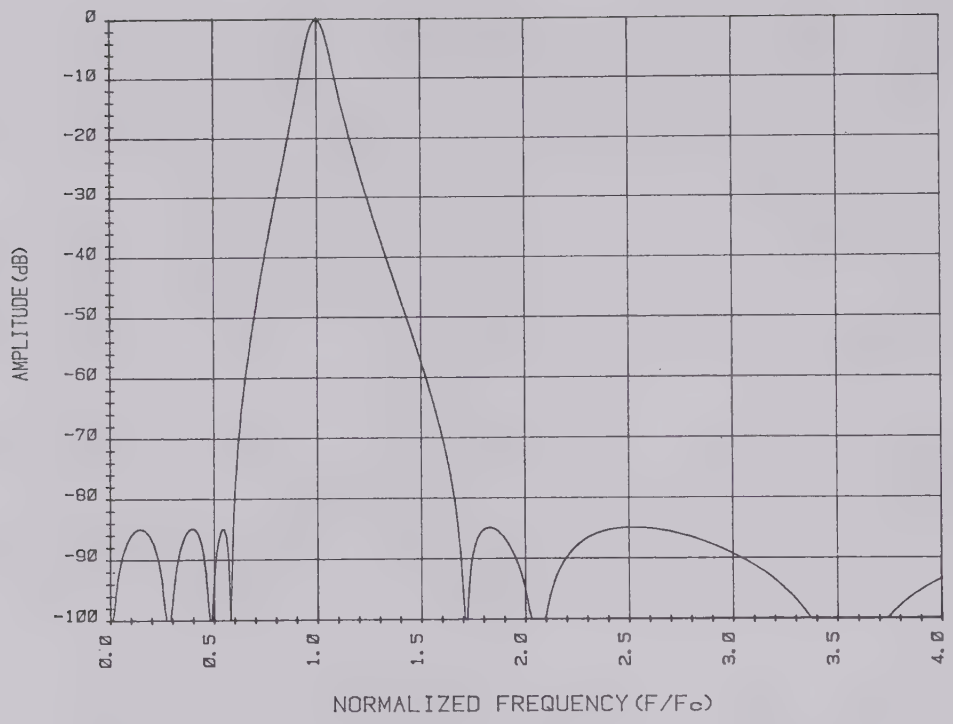


Fig. 3.3. Nominal Amplitude Response A

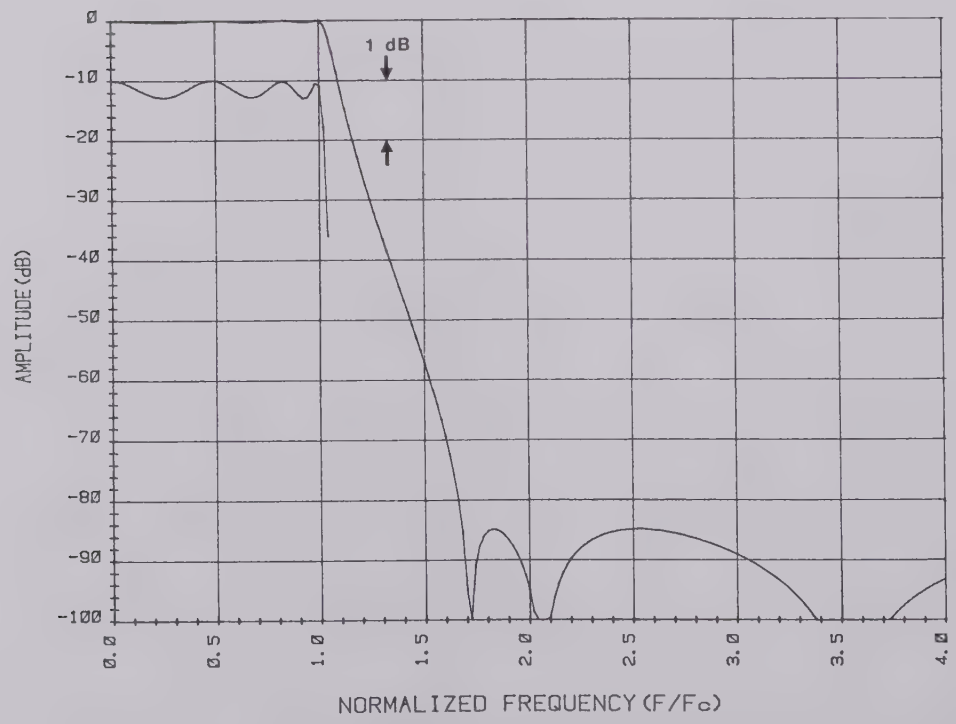


Fig. 3.4. Nominal Amplitude Response B

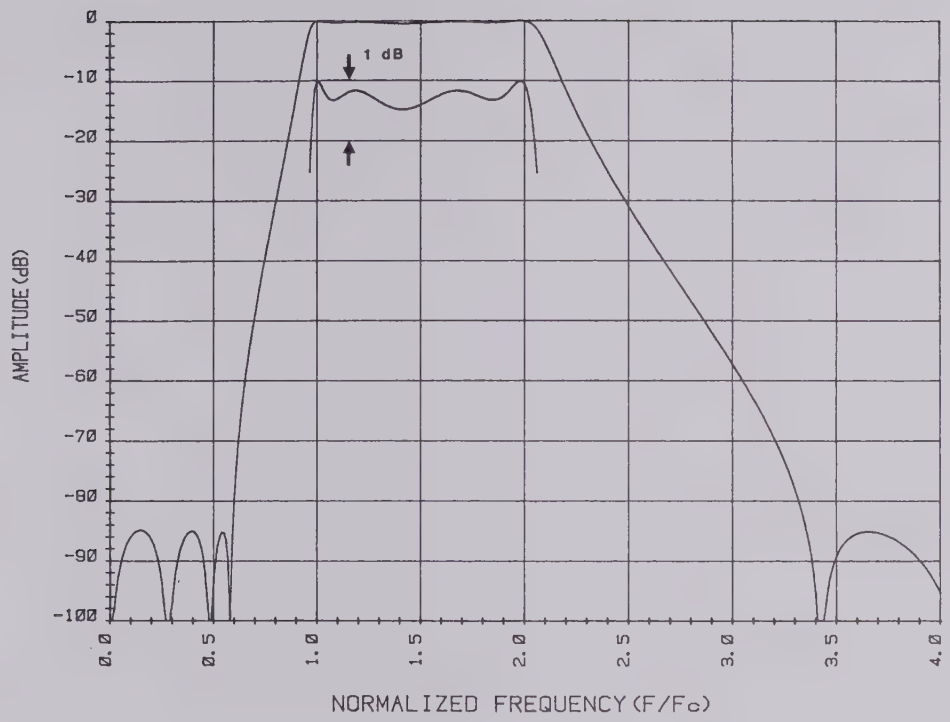


Fig. 3.5. Nominal Amplitude Response C

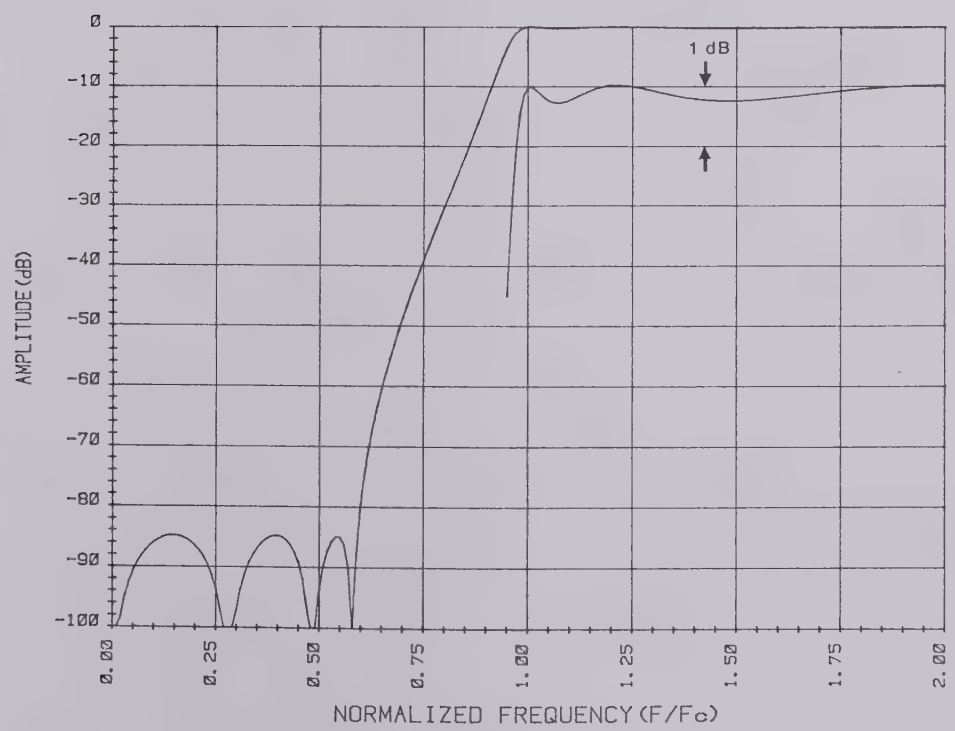


Fig. 3.6. Nominal Amplitude Response D

3-3. PROGRAMMING: IEEE 488 INTERFACE

3.3.1 Introduction

The reader is assumed to be familiar with the conventions of the IEEE 488/1978 standard digital interface. If not, a detailed description of the bus system and all its parameters, IEEE STD 488/1978 is available from:

IEEE Standards
347 East 47th Street
New York, New York 10017

The general principles for operating in a generalized system are discussed below.

This section will cover general principles and protocols for operating the System 716 in a generalized system. Specific implementation will depend on the particular details of the controller used.

3.3.2 Device Address Code and Mode Select Switches

The row of eight miniature rocker switches on the rear panel are used to set the device address code and other operating modes. See Section 3.1.7 for setup procedures.

3.3.3 Initialization

After power has been applied to all devices in the system, the Controller should:

1. Send REN (Remote Enable) active (low)
2. Send IFC (Interface Clear) active (low)
3. Send IFC inactive (high)

This will initialize all bus devices and send them to an idle state. Exercising the IFC line as above is also useful in reinitializing other devices on the bus whenever it may be necessary. The System 716 will assume the UNLISTEN-UNTALK state after this sequence.

3.3.4 Command Syntax

Commands must be transmitted as ASCII characters, and capital letters must be used. The commands consist of a required portion for each word and as many letters as desired to finish the word. The required portion is shown as the characters to the left of $ in the command list of Table 3.1. The option portion or any part, if used, must exactly correspond the the command description. A command is terminated with a carriage return, line feed or an IEEE 488 control line - "END" (EOI or ATN). Any one or combination of the three is acceptable.

Syntax Example:

Command: O$VERLOAD I$NTERRUPT E$NABLE

MINIMUM REQUIRED COMMAND:	"OIE"
POSSIBLE COMMAND:	"OV IN EN"
POSSIBLE COMMAND:	"OVER INT ENAB"
POSSIBLE COMMAND:	"OVERLOAD INTERRUPT ENABLE"
UNACCEPTABLE COMMAND:	"OVLD INT ENABLE"

Command List Dump:

The Command List (Table 3.1) can be "dumped" using the command "H$ELP". Several delimitters are used in the dump for display purposes and are not required in a command entry. Parenthesis separate commands. The dollar sign indicates the end of the required portion of a word. Other delimitters like semicolons, percent signs and question marks are special delimitters used by the interface program and can be disregarded.

Updates in the command list, if any, will be contained only in the software dump. Verify and update the command list in this manual using the help command to dump the command list.

TABLE 3.1

SYSTEM 716 COMMANDS

	DESCRIPTION
H$ELP	Outputs mnemonics for programming System 716 (600 characters)
REV	Outputs current software revision level (1 character)
REA$D; C$HANNEL	Outputs cutoff frequency, pre-gain, post-gain and channel number for current channel
REA$D; M$EMORY	Outputs channel information and group number stored in current memory
SET; F$REQUENCY	Inputs cutoff frequency (either Hz or KHz) to selected channel
SET; PR$E F$ILTER G$AIN; 40 $ DB; 30 $ DB; 20 $ DB; 10 $ DB; 0 $ DB	Inputs pre-filter gain to selected channel
SET; PO$ST F$ILTER G$AIN; 20 $ DB; 10 $ DB; 0 $ DB	Inputs post-filter gain for selected channel
SET; C$HANNEL	Inputs channel number (1-16)
SET; G$ROUP	Inputs group number in memory (1-16)
S$TORE FROM C$HANNEL	Transfers current channel information into current group number
L$OAD TO C$HANNEL	TRANSFERS stored channel information in current group number into current channel
M$ONITOR S$ELECTED C$HANNEL	Sets overload mode to selected channel. Monitors overload status to help in setting a channels gain
M$ONITOR A$LL C$HANNELS	Sets overload mode to all channels. Used during measurements to monitor status of all channels.
O$VERLOAD I$NTERRUPT D$ISABLE	Disables interrupts generated by overloads
O$VERLOAD I$NTERRUPT E$NABLE	Enables interrupts generated by 716 so overload status may be monitored

TABLE 3.1 SYSTEM 716 COMMANDS (continued)

	DESCRIPTION
O$VERLOAD R$ESET	Changes current overload mode. Alternates between Selected Channel and All Channels modes.
C$HANNEL A$LL	Provides capability for an action to all channels at once, e.g. load same cutoff frequency to all channels. Must be sent before action command is given - Load Channel, Store From Channel or Load To Channel
I$NCREMENT; C$HANNEL	Increments channel number and associated readouts by one (1)
I$CREMENT; G$ROUP	Increments group number by one (1) for subsequent transfers
S$TORE F$REQUENCY	Inputs cutoff frequency directly into current group number without changing current channel information
S$TORE; PR$E F$ILTER G$AIN	Inputs pre-filter gain into current group number without changing current channel information
S$TORE; PO$ST F$ILTER G$AIN	Inputs post-filter gain into current group number without changing current channel information

In each word, only characters to the left of the -$- are required!

3.3.5 Set Frequency Command

The frequency setting follows the format of either:

(NUMBER) Hz or,

(NUMBER) KHz

where (NUMBER) is a number of the format: $\emptyset\ \emptyset\ ..\ \emptyset_x\ d_x\ e_x\ f_x\ f_x\ ...f_x$

d is the first significant digit, $1 \leq d \leq 9$

e is the second significant digit, $0 \leq e \leq 9$

f's are digits following the first two significant digits and will be interpreted as $\emptyset$

x corresponds to the possible position of a decimal point, if used.

For example: the following will be interpreted as twenty-five hundred Hz: 2500 Hz, 2.5 KHz, as well as 2.512 Hz and 2.53 KHz.

An attempt to program a frequency greater than 100 KHz or less than 1 Hz generates an error SRQ.

3.3.6 Contiguous Commands

Frequency and gain settings may be grouped in one line separated by commas. All other commands must be transmitted individually followed by a carriage return and then line feed.

An example of a grouped command is "SET FREQ 10 KHz, PRFG 20, POFG 10" results in setting the filter at 10 KHz cutoff and the pre-and post-filter gains at 20 and 10 dB, respectively. Frequency and gain settings are the only commands that can be combined in one line separated by commas.

3.3.7 Service Request Interrupts From the System 716

Interrupts from the System 716 can be caused by a syntax error sent to the System 716 or an overload condition. Interrupts caused by input and output overload detectors will not cause an interrupt unless the "OVERLOAD INTERRUPT ENABLE" command has been sent to the System 716. The reason for an interrupt can be determined by a serial poll (Fig. 3.7).

Fig. 3.7 Format of Serial Poll Byte for Overload Error

	Command Error "Zero"	Always "One"	Overload Pre-filter Gain	Overload Post-filter Gain	Channel Number Minus 1			
Bits	8	7	6	5	4	3	2	1

If Bit 8 is a "Zero" the reason for an interrupt is an overload. Bit six and five indicate whether a pre-or post-filter overload has occurred. If the overload occurs only at the input, Bit 6 is a "one". While an overload only at the output results in a "one" in Bit 5. Occasionally, an overload may occur at both input and output. If so, Bits 5 and 6 will be "zero". Note, bits six and five are stored only when the OVERLOAD MONITOR is in the ALL CHANNELS mode. If, instead it is in the MONITOR SELECTED CHANNEL mode, overloads are reset and these two bits are not meaningfull unless the overload is continuous. Bits four, three, two, and one indicate the channel number minus 1 that is overloading (in binary). This number should be incremented by one to obtain the correct channel number.

When power is applied to System 716 it powers up with its overload interrupt capability enabled. Should an overload occur, and the IEEE Bus is active, then a service request, SRQ, will be generated. If a SRQ is not desired during the power up process, the OVERLOAD INTERRUPT DISABLE command should be sent to the System 716. However, if the interrupts generated by the overload is not disabled, then after an overload occurs, the System 716 will disable the interrupt capability to prevent more than one SRQ from being generated for each overload condition. When the proper action has been taken to eliminate the overload, i.e., reducing the filter gain, the OVERLOAD INTERRUPT ENABLE command must be sent to re-enable the System 716.

Fig. 3.8 Format of Serial Poll Byte for Syntax Error

	Command Error "One"	Always "One"	Identification of Syntax Error					
Bits	8	7	6	5	4	3	2	1

When Bit 8 of the serial poll is a "one" a syntax error has occurred. Bits one through six indicate the kind of syntax error. Of the sixty-four binary codes available, seven are used as follows:

0 Unknown Command
1 Non-numeric in numeric field
2 Error in frequency field
3 Channel or group number greater than 16
4 Input string greater than 128 characters
5 IEEE Bus error
6 IEEE Bus error

3.3.8 Programming Examples for the HP9825

3.3.8.a Dump Command List

Instructions	Comments
`0: dev "716";701`	0 Set Device Address (System 716 is set to address 01)
`1: dim H$[600]`	1 Dimension a word string
`2: wrt "716", "HELP"`	2 Send HELP command to 716
`3: red "716";H$`	3 Read list of commands
`4: prt H$`	4 Print command list
`5: end`	
`*21566`	

3.3.8b Count number of overloads that occur and display channel number

```
0: "COUNT OVLDS"
 :
1: fxd 0
2: dev "716";716
3: oni 7;"ISVC"
4: polc "716",3
5: eir 7
6: wrt "716",
 "OIE"
7: wrt "716",
 "MAC"
8: 0→C
9: wrt "716",
 "SET C 1"
10: wrt "716",
 "SET F 65KHZ"
11: "LOOP":gto
 "LOOP"
12: "ISVC":
13: pol(7)→A
14: if A#8;prt
 "WRONG DEVICE";
 eir 7;iret
15: rds("716")→B
16: if B>127;
 prt "SYNTAX
 ERROR!";eir 7;
 iret
17: C+1→C
18: wait 200
19: dsp A,B,C
20: wrt "716",
 "OR"
21: wrt "716",
 "OIE"
22: eir 7
23: iret
24: end
*10622
```

```
0:   Count OVLDS
1:
2:   716 set to device address 16
3:   On an interrupt (SRQ), go to "ISVC" routine
4:   Configure 716 to parallel poll bit #3
     (decimal 8)
5:   Enable HP9825A interrupt capability
6:   Enable 716 overload interrupt capability
7:   Set 716 overload mode to Monitor All Channels
     (MAC)
8:
9:   Set 716 channel number to 1 (one)
10:  Set 716 cutoff frequency to 65 KHz
11:  Wait for overload to occur
12:  Service sub-routine
13:  Parallel poll to find out which device
     requires service
14:  If 716 did not send SRQ, return
15:  Read serial poll register
16:  If overload did not cause SRQ, return
17:  Increment overload counter
18:
19:
20:  Reset overload status - clear SRQ
21:  Re-enable overload interrupt
```

```
0: "POLLING--1":
1: dev "716",716
2: oni 7,"SERVIC
 E"
3: polc "716",2
4: eir 7
5: beep
6: dsp "ENTER
 COMMAND WITH
 SYNTAX ERROR"
7: prt "example
 - wrt""716"",
 ""SET GROUP
 0"""
8: gto +0
9: end
10: "SERVICE":
11: pol(7)→P
12: if P#4;eir
 7;iret
13: rds("716")→R
14: if bit(7,R);
 gto "SYNTAX"
15: if bit(5,R);
 prt "OVLD -
 PRE GAIN";beep;
 R-96→R;jmp 2
16: prt "OVLD -
 POST GAIN";beep
 ;R-80→R
17: R+1→C
18: fxd 0
19: prt "on CHAN
 NEL #",C
20: gto "IRET"
21: "SYNTAX":
22: R-192→R
23: fxd 0
24: prt "--SYNTA
 X ERROR--"
25: prt "error
 #",R
26: "IRET":
27: eir 7
28: dsp "again?
  NEW SYNTAX
 ERROR"
29: iret
30: end
*14270
```

System 716 is set to device address #16. On an interrupt, go to SERVICE routine.

Assign 716 to parallel poll bit #2 (decimal 4). Enable the calculator interrupt capability.

Sample of statements containing syntax errors.

Service request routine.

Check if 716 (poll = 4) generated by SRQ.

Read serial poll register
If bit #7 (MSB) = 1, go to syntax error routine, otherwise check for OVERLOAD.

Determines which channel overloaded and if the overload occurred before (pre-filter) or after (post-filter) the filter

Print overloaded channel number

Syntax error routine

Determines type of syntax error. Check manual for list of possible errors

```
100 REMARK          ----------------------------------
110 REMARK          [ SYSTEM 716 SAMPLE TEST PROGRAM ]
120 REMARK          [ USING THE WAVETEK/ROCKLAND 716 ]
130 REMARK              [ AND THE TEKTRONIX 4051 ]
140 REMARK          ----------------------------------
150 REMARK
160 REMARK                  ( NOTE: SYSTEM 716 )
170 REMARK            ( DEVICE CODE IS SET TO NO. 4 )
180 REMARK
190 REMARK                  --------------------
200 REMARK                  [ THE HELP COMMAND ]
210 REMARK                  --------------------
220 INIT
230 PAGE
240 PRINT "*** THE HELP COMMAND ***"
250 PRINT
260 PRINT
270 DELETE H$
280 DIM H$(600)
290 PRINT @4,32:"HELP"
300 ON SRQ THEN 530
310 INPUT @4,32:H$
320 PRINT H$
330 PRINT
340 PRINT
350 REMARK          ----------------------------------
360 REMARK          [ INTENTIONAL GENERATION OF SRQ  ]
370 REMARK          [ BY SENDING A FORMAT WORD ERROR ]
380 REMARK          ----------------------------------
390 REMARK
400 PRINT @4,32:"HLEP"
410 ON SRQ THEN 530
420 PRINT
430 PRINT
440 PRINT
450 PRINT
460 PRINT "END OF SAMPLE TEST PROGRAM."
470 END
480 REMARK
490 REMARK          ----------------------------------
500 REMARK          [ SERVICE REQUEST - SERIAL POLL ]
510 REMARK          ----------------------------------
520 REMARK
530 POLL M,W;4
540 GO TO M OF 550
550 PRINT "==============================="
560 PRINT "SYSTEM 716 STATUS WORD IS: ";W
570 PRINT "==============================="
580 PRINT @4,32:"OVERLOAD RESET"
590 PRINT @4,32:"OVERLOAD INTERRUPT DISABLE"
600 RETURN
610 REMARK ------------------------------------------------------------
```

SECTION 4
THEORY OF OPERATION

4-1. INTRODUCTION

The System 716 Mainframe consists of an eighteen slot card cage. Sixteen of these slots are allocated to filters. The slot on the left, while facing the front panel is filter channel one. The channels are numbered consecutively one to sixteen. Slot seventeen must contain the "IEEE/Scanner" board. This board has an IEEE interface processor and control circuitry to control and monitor all sixteen filters. Slot eighteen is unallocated. All cards plug into a printed circuit mainboard. The mainboard has two flat cable connectors. One is fifty pin which goes to the front panel PC card, the other is thirty-four pin which goes to the rear panel and connects to the IEEE Bus. Filter inputs and outputs are connected via coax cable to rear panel BNC connectors.

4-2. FRONT PANEL

The front panel and its associated printed circuit card serves as data entry and display (see block diagram Fig. 4.1). The IEEE 488 Interface is another data entry and monitor path which is mutually exclusive from the front panel. The front panel can be disconnected from the mainboard and the IEEE will still monitor and control the filters. Conversely, the front panel will monitor and control the filters without the IEEE processor. The front panel rotary switches are all "BCD Active Low" coded, except the frequency multiplier switch. For example, a setting of one Hertz results in (1111) appearing on the frequency tens digit data lines, (1110) on the frequency unit digit data lines. Note that the multiplier switch is not coded: times one is (1110), times ten is (1101), times one hundred is (1011), times 1K is (0111). Rotary switch contacts are connected to inverting tristate BUS drivers. The drivers are activated only when a command to load a channel is given. With no load command the drivers remain tristate inactive. The data lines are driven from the selected channel, and the seven segment decoders (Fig. 4.1) display the selected channel data.

All push buttons are wired to the IEEE Scanner Board via the fifty pin connector. The switch lines are active low. One side of all the switches are connected to a driver that provides this low level. If the driver output is forced high by the remote IEEE 488 line, none of the switches will be capable of forcing its function low. The remote light is then turned on.

4-3. IEEE/SCANNER BOARD

4.3.1 Introduction

The IEEE/Scanner Board is divided into three major sections: the IEEE 488 Processor is used only for IEEE interface functions and operates continuously. The Scanner and Parameter Control sections contain all the circuitry required for front panel control.

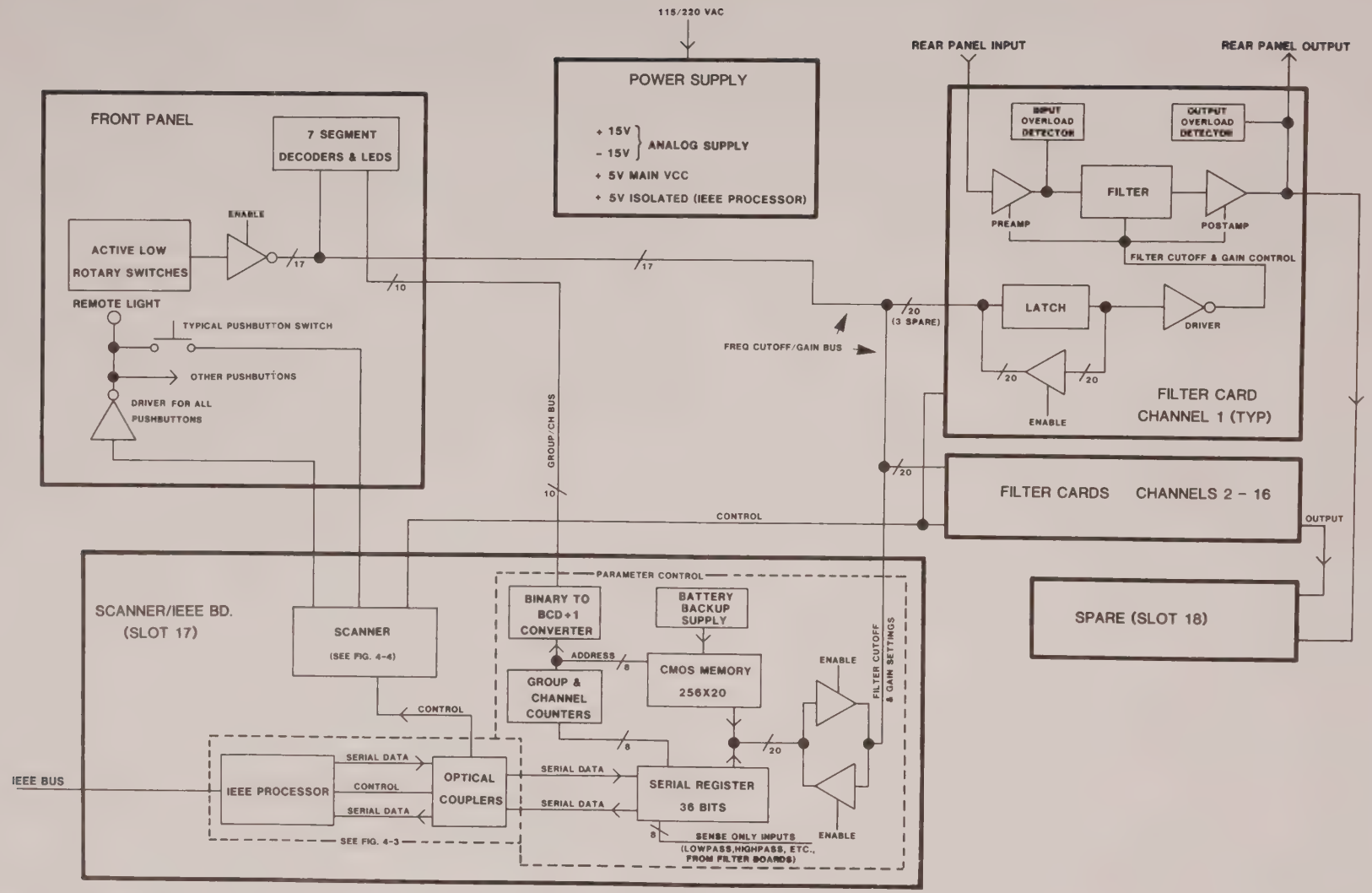


Fig. 4.1. Overall Block Diagram

To avoid generating unwanted signals, there are no continuously operating oscillators in the Parameter Control Section. They are turned on only when a specific task is to be performed, and go off automatically when the task is complete. In this way no coupling of control frequencies can contaminate a filter. In addition, control signals in the IEEE 488 section will not pass to the Scanner section because the power supply and grounds for each section are independent and signals that pass between sections are optically coupled.

The following sections will describe the IEEE 488 section, the optically coupled control signals, and then the Parameter Control section.

4.3.2 General Description of the IEEE-Std 488 Interface

This section will provide an abbreviated description of the IEEE Standard Digital Interface for Programmable Instrumentation otherwise referred to as IEEE-STD 488/1978, or GPIB (General Purpose Interface Bus). For a thorough and rigorous definition of this system, a copy of the standard may be obtained from:

IEEE Standards
347 East 47th Street
New York, New York 10017 U.S.A

In general, the standard provides a physical and electrical specification to permit instruments to communicate data and control information to each other. There are three basic types of functions performed by devices connected to the bus. These functions are:

-Controller
-Talker
-Listener

Each device may possess one or more of these functions. Usually, only one device has the controller function such as a computer or programmable calculator. The controller is able to specify which of the other devices are active, control the flow of data between devices, and, in general, supervise the system.

Talkers are able to send data, and listeners are able to receive data. The controller must decide for a given transfer, which device is the talker and which device (or devices) is the listener. This is accomplished by assigning a unique device address code to each device on the bus, and by directing the controller to address and set up each device appropriately. The controller is also able to respond to interrupts and to generate trigger and clear commands.

4.3.2a Bus Lines

The following table lists the sixteen lines present in the bus system:

MNEMONIC	NAME	FUNCTION
DIO1 thru DIO8	Data Line	Bi-directional Data Lines
DAV NRFD NDAC	Data Valid Not Ready for Data Not Data Accepted	Three-Wire Handshake
IFC ATN SRQ REN EOI	Interface Clear Attention Service Request Remote Enable End or Identify	Control Lines

DIO1 thru DIO8--Data Lines

All data, including device address codes, are transmitted over these eight lines. Usually, the data is sent as 7-bit ASCII characters, one byte or character at a time in a variable-length, serial sequence.

ATN - Attention

This control line is made active (low) by the controller when it sends device address codes over the data bus to change the talker/listener status of devices on the bus, or to send universal commands which must be acknowledged by all devices. When ATN is inactive (high) the data bus transfers the present input or output data.

IFC - Interface Clear

The controller makes IFC active (low) when it wishes to abort all activity on the bus and disable all devices from listening, talking or requesting service. Bus activity may not resume until IFC is returned high.

REN - Remote Enable

Remote enable, issued by the controller, must be active (low) to permit remote control operation of any device on the bus. Usually, when the line is active, front panel controls on instruments are disabled and remote inputs from the bus are accepted.

SRQ - Service Request

This line, driven by an device, indicates that some from of service is requested in the system.

EOI - End or Identify

Usually issued by a talker to designate the end of a character string. This line is also used in responding to service requests.

DAV - Data Valid

When this line is active (low) the data on the data bus is valid. This line is driven by the active talker.

NRFD - Not Ready for Data

This line is made active (low) by any listener before a data transfer takes place to indicate that it is not ready to accept data. Only when NONE of the listeners cause NFRD to be active can the data transfer take place. This line is read by the talker or controller which is attempting to send data.

NDAC - Not Data Accepted

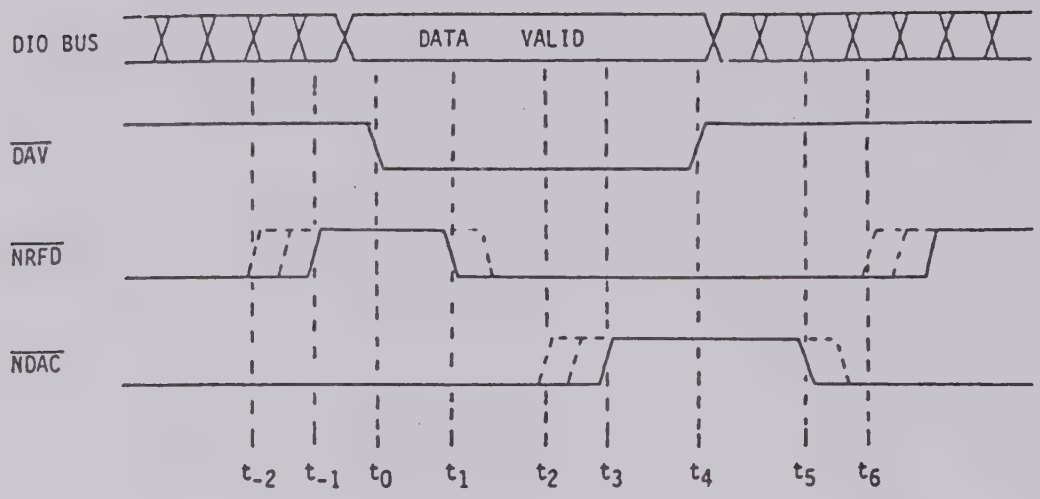
Again, this line is made active (low) by any listener to extend the data transfer cycle so that it may be able to accept the data. Only when NONE of the listeners cause NDAC to be active can the data transfer be completed. This line is read by the talker or controller which is sending the data.

4.3.2b Data Handshake Cycle

Fig. 4.2 shows the timing relationship involved in the three handshake control lines DAV, NRFD, and NDAC.

If during this handshake cycle, ATN is active, then the handshake represents a controller command and all devices must participate in the handshake. If ATN is inactive, then only addressed listeners participate.

By holding either NRFD or NDAC active, any listener can prolong the handshake cycle allowing the slowest device to govern the data transfer rate.



t_{-2} First listener releases NRFD line indicating ready for data.

t_{-1} Last listener releases NRFD, letting it go inactive.

t_0 Upon sensing NRFD inactive, the talker sends data valid on the data bus and now sends DAV low indicating data is valid.

t_1 Upon sensing DAV active, each listener drives NRFD active indicating none are ready for more data.

t_2 First listener has accepted data and releases NDAC.

t_3 Last listener accepts data and releases NDAC causing it to go inactive.

t_4 Upon sensing NDAC high, the talker realizes all devices have accepted the data, takes DAV inactive, and removes data from the bus.

t_5 After sensing DAV has gone inactive, all listeners drive NDAC active.

t_6 When the first listener is ready to receive more data, it releases NRFD. This state is identical to t_{-2}, and the entire sequence repeats.

Fig. 4.2 Timing Relationship for Handshake Control

The acceptor handshake function provides for the three wire data handshake described above. The listener function is required for it to accept program data from the bus.

Listen Always is provided to allow simpler systems (where there may be only one listener) to avoid the overhead of always addressing the System 716. In addition, if the system is so simple that it does not actually need a controller, a talker with a Talk Only function and a listener with Listen Only function can constitute an operational system alone.

4.3.3 IEEE-488/1978 Std. Processor

The IEEE processor section provides the System 716 Filter with an interface to the IEEE-488 Std Bus. The interface allows programming or sensing with ASCII data transfers. The interface satisfies the following functions of the IEEE-488 Std: SH1, AH1, T6, TE0, L3, LE0, SR1, PP1, DC1, DT0, C0, E1.

The IEEE Processor section consists of two microprocessors, see Fig. 4.1. The first is an IEEE Controller chip that provides the correct interface protocols between the IEEE-488 Std Bus and a second processor, Z-80. The Z-80 performs the necessary interface between the IEEE Processor and the System 716. It connects to the System 716 through an 8-bit register (Intersection Communication Register) for output communication with the Scanner and Parameter Control sections. One Serial Data Line and an Interrupt line serve as incoming communication from the other sections to the IEEE processor.

The Z-80 microprocessor operates from a Read Only Memory (ROM) as its program source and a static Random Access Memory (RAM) is provided for support.

4.3.4 Optically Coupled Signals

Communication is through optically coupled data and control lines (Fig. 4.1 and 4.3). These lines consist of two serial data, one in and the second out, and seven control lines.

Communication to the Parameter Control section is through a 36-bit long serial register (Fig. 4.1). It is serial loaded by the IEEE Processor and parallel loaded from the Parameter Control section.

Data in the 36-bit serial register is divided as follows: 20-bits for cutoff frequency and gain settings, of which 3 are spare; 8-bits for the group and channel numbers; another 8-bits for Sense Only functions, consisting of 5-bits to sense the type of filter, 2-bits for input and output overload conditions and one bit to sense the overload mode.

Eight lines come from the Intersection Communication Register (Fig. 4.3). They include 3 mode lines, Interrupt Mask, Remote, Serial Clock, Counter/Load and Serial Data 1.

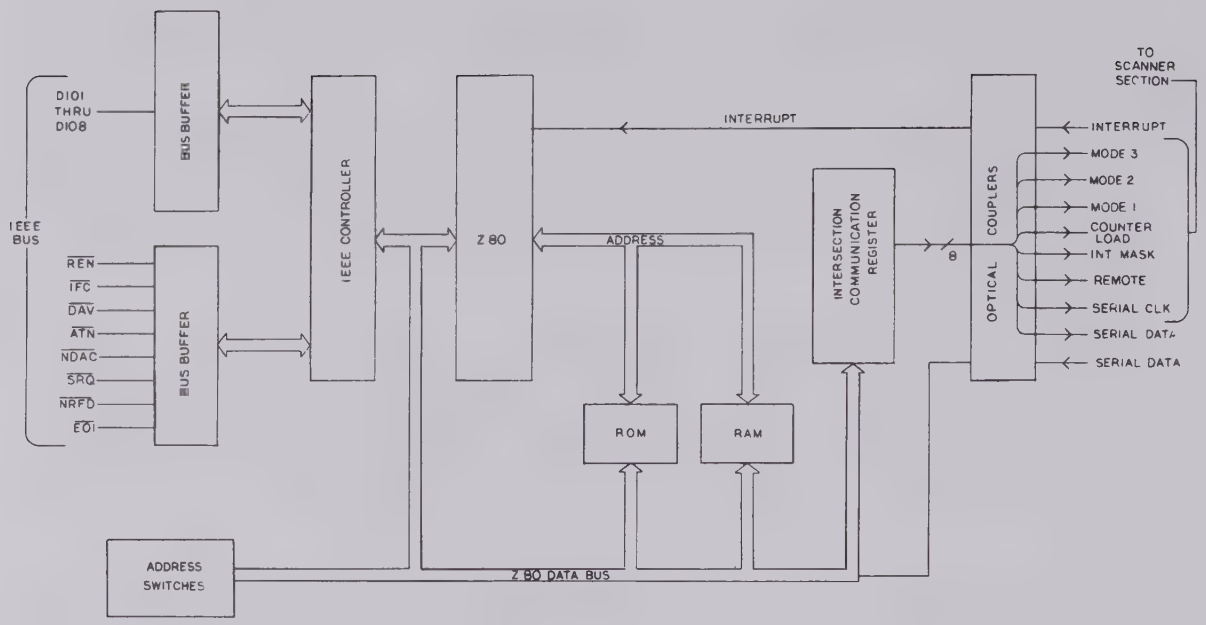


Fig. 4.3. IEEE Processor Block Diagram

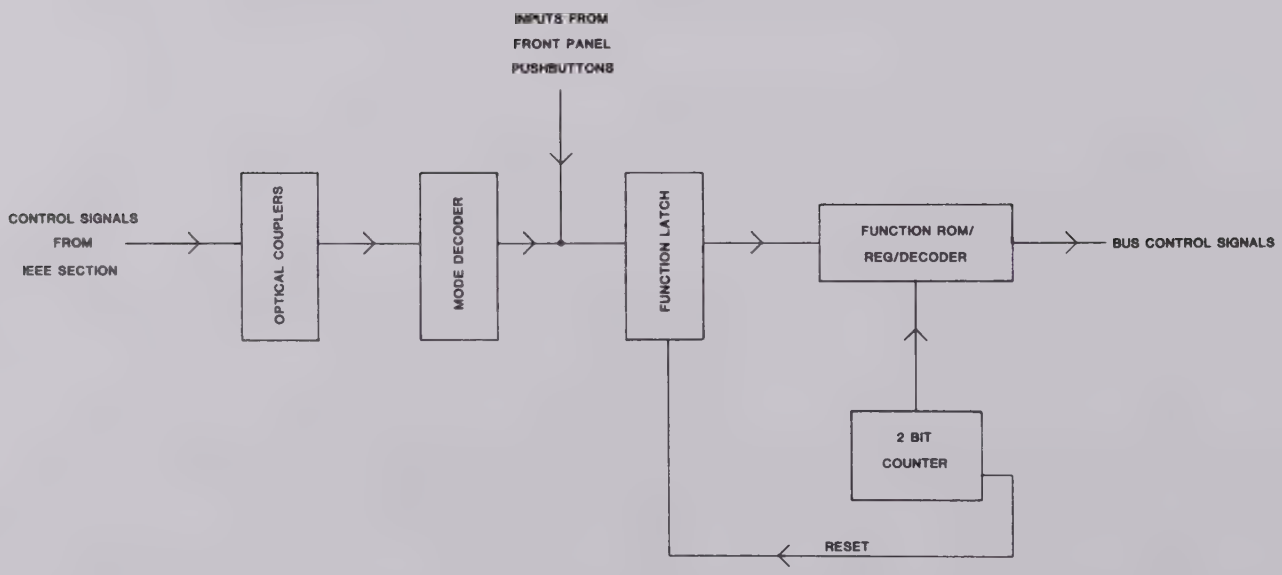


Fig. 4.4. Scanner Block Diagram

The Serial Data and Serial Clock lines are used to send data to the 36-bit register (Fig. 4.1).

The Interrupt Mask is a hardware mask that inhibits an overload in a filter from causing an interrupt to the Z-80 (Fig. 4.3).

The three mode lines are decoded to perform seven operations. They are: loading Group and Channel Numbers from the 36-bit Serial Register into the Channel Counters (Fig. 4.1), transfers of data from the Serial Register into the CMOS Memory and back, Cutoff/Gain from a channel to Serial Register and back, CMOS Memory to Cutoff/Gain for a channel and back.

The three mode lines are decoded in the Scanner section and then the results are used to pulse the desired function line.

4.3.5 Scanner Section (Fig. 4.4)

Control inputs to the Function Latch can come from the IEEE section or front panel push button switches. In some cases both lines are actually tied together. The Function Latch drives a Function ROM, Register and Decoder. The Decoder's outputs are the actual control lines that enable signals on the various buses. When an input enters the Function Latch, an oscillator is turned on and increments a 2-bit counter. The counter outputs allow four sequential states from the ROM/Decoder. A typical sequence to load the front panel data into a filter channel would be:

1. Enable front panel tristate drivers onto the Cutoff/Gain bus, disable channel output drivers and memory bi-directional buffer. Data is now available at input to Latches in the filter channel.

2. Send latch pulse to selected channel.

3. Restore state 1.

4. Disable front panel drivers and enable channel drivers so that LED decoders monitor the selected channel.

At the end of this sequence the oscillator is turned off and the system is left in state four.

4.3.6 Parameter Control Section (Fig. 4.1)

This section includes the Group and Channel counters and Binary-to-BCD converter for display of group and channel number on the front panel.

The binary outputs from the counters are used to address the CMOS Memory which can store cutoff frequency and gain for 16 groups each with 16 filter channels. The channel address is decoded so that a separate enable line is sent to each channel indicating when it is selected.

4-4. FILTER CHANNEL

4.4.1 Filter Channel-Introduction

This section describes the basic principles of the filters used in the System 716. Fig. 4.5 is a block diagram for a filter channel.

4.4.2 Block Diagram Description

The input signal is applied through a 0/20 dB Input Attenuator, followed by a high impedance buffer Pre-amplifier whose gain is variable in 10 dB steps over a 20 dB range. The Input Attenuator provides a constant 1 Megaohm input resistance in any position. The output of the Pre-amplifier is applied to a cascade of one passive RC, 1st order filter (6 dB/octave) and three "2nd-order prototypes". A "2nd-order prototype" is an active RC, 2nd-order (12 dB/octave) filter section which is used as a building block to synthesize higher-order filters. The output of the filter sections are followed by a Post-amplifier whose gain may be varied over 20 dB range in 10 dB steps.

The gain of the subsections at dc are as follows:

GAIN AT DC

	Elliptic Low Pass	Elliptic High Pass
Input Attenuator-dB	0/-20	0/-20
Pre-amplifier-dB	0/10/20	10/20/30
Filter-dB	0	0
Post-amplifier-dB	20/30/40	10/20/30

Overload detectors are present at the output of the pre-and post-amplifiers. An input overload is detected when the output of the pre-amplifier exceeds 1 volt magnitude for the low pass filter and 3 volts magnitude for the high-pass filter. The output overload detector for either filter is set for a threshold of 10 volts magnitude.

Cutoff frequency control is obtained by changing the resistors of the filter stages in 8-4-2-1 BCD steps. The capacitors are changed in decade steps. These components are switched by relays and FET's.

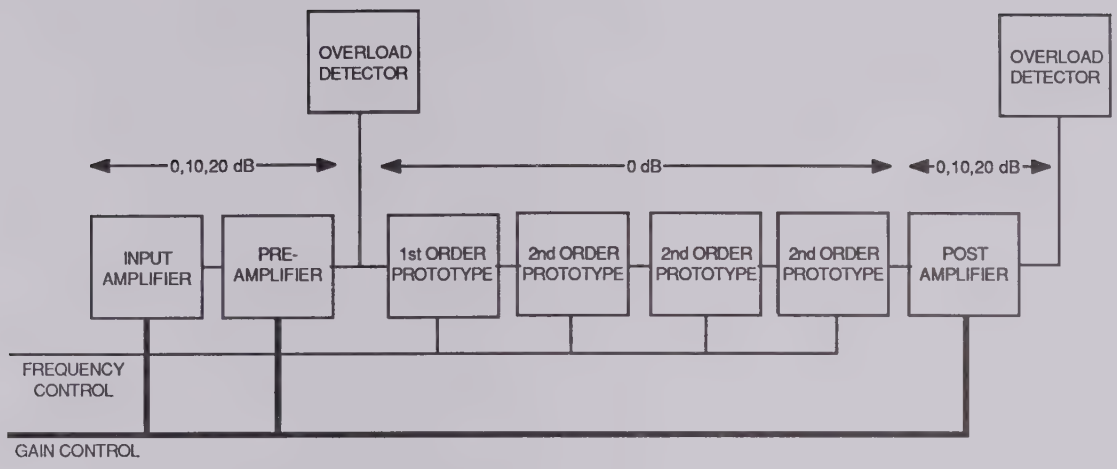


Fig. 4.5. Filter Channel Block Diagram

4.4.3 2nd-Order Prototype

Fig. 4.6 is a simplified form of the 2nd-order prototype used to construct either the low pass or high pass filter channels. The form of the building block is known as a state-variable filter.

The difference between a low pass and high pass prototype is the value of poles and zeroes, i.e., RC's required and the gain for the two inputs to the summing amplifier.

Phase shifts through the non-ideal amplifiers seriously degrade the filters transfer function at higher frequencies, typically above 10 KHz. A patented technique* is used to introduce compensating phase shift, so that the transfer function of the amplifiers for different frequencies is substantially identical.

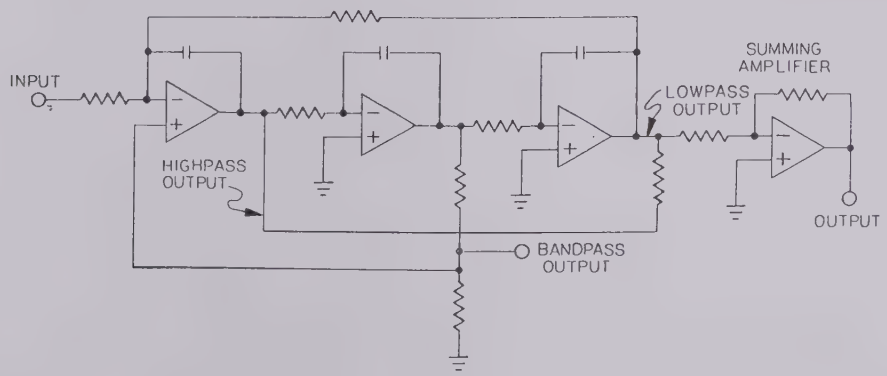


Fig. 4.6. Simplified 2nd-Order Prototype

*Patent No. 4,246,542, Thanos, "Filter Using a State-Variable Biquadratic Transfer Function Circuit", Jan. 20, 1981.

SECTION 5
MAINTENANCE

5-1. INTRODUCTION

This section describes recommended test procedures to verify that the instrument is functioning properly and that it meets its performance specifications.

Troubleshooting and repair procedures will first be covered.

5-2. TROUBLESHOOTING PROCEDURES

5.2.1 Basic Troubleshooting

Basic to any troubleshooting procedure is to see that the power supply is operating properly. Only qualified personnel should attempt servicing. Some stored voltage may be present on power supply terminals even when the power cord has been removed from the unit. Check rear panel AC fuse. Check also two fuses on the mainboard assembly (accessable when the bottom cover is removed). The two fuses protect + 5VDC. One fuse feeds power to all the filter channels and the other protects the front panel, IEEE/Scanner board and the unallocated slot, number 18. Use only exact replacements for fuses when replacement is necessary.

5.2.2 System Troubleshooting

Self diagnostics are performed on power turn-on for testing some data and control paths and critical control circuits.

When the diagnostics are performed, the remote light is automatically turned on and all front panel controls are disabled while the remote light is on. Failure of any test is shown on the seven segment group and channel displays. If a test fails, an "E" is displayed instead of group number and the test number is displayed instead of channel number.

A microprocessor on the Scanner/IEEE board controls all tests. The tests performed are:

TEST 1

This test exercises the random access memory that is used in support of the microprocessor. E1 is displayed if any failure is found.

TEST 2

Checks the thirty-six bit serial shift register on the Scanner/IEEE board. Error E2 is displayed if the microprocessor cannot serially load and read back the same data. When this test fails the processor loops around the diagnostic to aid in troubleshooting.

TEST 3

This test loads data from the microprocessor into the serial 36 bit register, transfers the data to one group memory location and then checks the data to see if this type of data transfer is operational. E3 is displayed if a failure occurs.

TEST 4

This test sets and reads the overload mode to see if it can be remotely programmed. E4 is displayed if any error is detected.

TEST 5

Test five checks several modes and data paths. Data is transferred from one location of the group memory to the microprocessor where it is saved. The data is then transferred from the same group memory location to a filter channel. The microprocessor then reads the data in the filter channel and compares it with the previously stored data. If the data is correct, the test continues. A complement of the data is transferred to the same group memory location. This data is written over by data still stored in the filter channel. The data is again read from the group memory by the microprocessor and checked. E5 is displayed if any failure is detected.

TEST 6

This test sets all filter channel gains to zero dB and all cutoff frequencies to 50 KHz. All filter channels are then checked for these settings. If any error is detected E6 is displayed. The filter channels are left with these settings as the remote light is turned out indicating the end of diagnostic testing.

If a failure is detected:

Operation of the system cannot proceed unless diagnostics are restarted or diagnostics bypassed. Diagnostics can be bypassed by powering up in the "Listen Always" mode selected on the rear panel so that troubleshooting can take place. Diagnosing and troubleshooting procedures will be more effective after reading the section of Theory of Operation.

5.2.3 Remote IEEE-488 Troubleshooting

5.2.3a Introduction

In the event that the bus system is not performing correctly, many functional tests can be made to help locate the cause. In general, an effort should be made to reduce both the hardware and software complexity of the system to the simplest configuration which still exhibits the problem.

Since the System 716 was exhaustively tested prior to shipment, the probability is low that problems encountered when first setting up the system with an IEEE Controller are due to hardware failures. It is more likely that some set-up parameter, device address, or software convention is causing the problem.

5.2.3b Check List of Set-up Problems

Before attempting diagnostic tests, the following list of common set-up errors should be checked:

1. Make sure power is applied to all units connected to the bus system. Although not true of the System 716, some units, when power is off, will load the bus and cause transmission failures.

2. Check tightness of the bus cable connectors. A connector which is not secured by the captive screws may become partially disengaged from its mounting socket causing intermittent or open connections.

3. Review the address code structure of the system making sure that no two devices unintentionally share the same address code. Make sure the controller is correctly identifying each device by its respective address.

4. Make sure the cable between the System 716 and its companion instrument is correctly installed and locked into place at both ends.

5.2.3c Diagnostic Tests

Problems can generally be classified as either related to the bus system operation or to the instrument operation. The controller is usually provided with some fault-indicating messages which can be useful in diagnosing bus problems.

The most basic bus activity is the handshake function which is required for all universal commands and data transfers. The controller will generally indicate if there is a problem in completing the handshake. If a problem exists, the offending device can be determined by connecting devices to the bus one at a time.

The next level of activity is establishing the various devices as active listeners or talkers. The System 716 indicates its status by the REMOTE LED. Each bus device should respond appropriately to these universal commands and not interfere with each other. A unit-by-unit check of these operations will verify correct performance of these functions.

If the above tests have not uncovered the problem and troubleshooting of the hardware is required, then the Theory of Operation with Block Diagrams should be used to help trace the problem.

WARNING

EXTREME CARE MUST BE USED IN SERVICING
THIS INSTRUMENT SINCE HAZARDOUS VOLTAGES
ARE PRESENT INSIDE THE CASE.

5-3. FILTER CARD TROUBLESHOOTING

Each filter has been adjusted against a reference at the factory. As a result, do not attempt to replace or repair any amplifiers, resistors or capcitors in the filter sections. Relays may be replaced. Similarly, adjustments should not be disturbed except for DC offset.

5-4. FACTORY ASSISTANCE

If the problems cannot be remedied by these procedures, factory assistance is available by calling or writing:

Customer Service Department
Wavetek San Diego, Inc.
P.O. Box 85265
San Diego, CA 92138
Tel 619/279-2200
TWX 910/335-2007

Do not return a unit to the factory. Check with Customer Service for authorization.

5-5. PERFORMANCE TESTS

This section describes recommended test procedures to verify that the instrument meets its performance specifications. In addition, adjustment procedures are described so that an instrument may be calibrated to meet specifications.

NOTE

The completion of the calibration procedure returns the instrument to correct alignment.

CALIBRATION LIMITS AND TOLERANCES ARE NOT INSTRUMENT SPECIFICATIONS

Instrument specifications are given in Section 1 of this manual.

5.5.1 Recommended Test Equipment

The recommended test equipment and its use is listed below:

Description (Feature)	Model	Tests
Oscilloscope	Tektronix 935A	Full-scale
Digital Multimeter (100 uV dc resolution)	Data Precision 2480R	DC Offset

AC Voltmeter (2 req'd) (1% accuracy)	Fluke 8922A	Passband ripple, cutoff frequency accuracy, overload indicators, phase match, amplitude match
Frequency Counter (1 Hz to 100 KHz range .001% accuracy)	Hewlett-Packard 5315A	Cutoff frequency accuracy (optional)
Frequency Synthesizer (1 Hz to 100 KHz range)	Wavetek Rockland 5100	Passband gain, cutoff frequency accuracy, phase match
Phase Meter (+ .25 degrees)	Dranetz 305 PA 3009A	Phase match
Function Generator (1 Hz to 100 KHz)	Wavetek 143	Full-scale signal overload indicators
Attenuator (102.5 dB)	Kay 437A	Gain steps

5.5.2 Additional Equipment For Sample Test
(Test procedures will be furnished upon request)

Description (Feature)	Model	Tests
Spectrum Analyzer (5 Hz - 50 KHz)	Hewlett-Packard 3580A	Harmonic components, intermodulation distortion, out-of-band selectivity
Oscillator (<-85 dB distortion)	Hewlett-Packard 239A	Harmonic components
Graphics Computing System	Tektronix 4051	Functional check
Spectrum Analyzer	Wavetek Rockland 7530	Noise, crosstalk AC line related spurious
50-Ohm Termination	-	-
5 K Load Resistor	-	-

WARNING

The specifications of these instruments cannot be verified, unless the recommended equipment (or equal) is utilized in test. In particular, Function Generators cannot be used in place of the recommended signal source. Function Generators produce high harmonics in their output waveform and will cause considerable error in certain tests requiring the use of a signal source.

5.5.3 TEST 1 PASSBAND RIPPLE SPECIFICATION 0.8 dB P-P MAXIMUM

A. Setup the test equipment as shown in Fig. 5.1. (connect the equipment to channel under test)

B. Set the filter cutoff frequency to 80 x 1.

C. Set pre-gain and post-gain to 0 dB.

D. Tune the frequency synthesizer (within the operating passband) while observing the maximum and minimum levels shown on the AC voltmeter. (Do not exceed the cutoff frequency limits).

E. Measure the ripple (peak to peak amplitude) by subtracting the minimum from the maximum levels.

F. Using this method, measure the ripple at each of the cutoff frequency settings listed on the Test Data Sheet.

G. Repeat this test for each occupied filter channel.

TEST 2 CUTOFF FREQUENCY ACCURACY

SPECIFICATION HIGH PASS FILTER, +0%, -3.5% MAX.
LOW PASS FILTER, -0%, +3.5% MAX.

NOTE: This test will be performed at a reference level 0.6 dB down, for convience of measurement. Actual cutoff frequency may be determined by interpolating data (to 0.3 dB level) on a curve.

A. Set up the test equipment as shown in Fig. 5.1. (Connect the equipment to channel under test).

B. Adjust the frequency synthesizer to provide a 1 KHz sinewave at a level of 0 dBm. (Attenuator at 0 dB).

C. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	10 x 100 (1000 Hz)

D. Measure the output level of the filter. This level (0 dBm ±0.25 dB) is the reference to be used for determining the 0.6 dB measurement point. (Example: if reference level is -0.1 dB, the cutoff frequency should be measured at the -0.7 dB level).

E. Set the cutoff frequency Hz to 80 x 1 (80 Hz).

F. Tune the frequency synthesizer to the cutoff frequency setting on the System 716.

G. Slowly vary the synthesizer frequency around the cutoff frequency until the AC Voltmeter (at the filter output) is 0.6 dB below the reference (0 dB ±0.25) level.

H. Measure the output frequency from the synthesizer and record the frequency on the test data sheet.

I. Repeat steps C through H for all the frequency settings listed on the test data sheet.

J. Repeat this test for each occupied filter channel.

TEST 3 GAIN STEP TEST

SPECIFICATION Pre-filter Gain 0 to 40 dB ±0.25 dB
Post-filter Gain 0 to 20 dB ±0.25 dB

A. Set up the test equipment as shown in Fig. 5.1 (Connect the equipment to channel under test).

B. Adjust the frequency synthesizer to provide a 1 KHz sinewave at a level of 0 dBm. (Attenuator at 0 dB).

C. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	10 x 100 (1000 Hz)

D. Measure the output level of the filter. This level should be 0 dBm ±0.25 dB.

E. Record the output level on the test data sheet.

F. Set the pre-gain dB to +10 and insert 10 dB of attenuation on the input Kay attenuator.

G. Measure the level into the filter and adjust the synthesizer output level to compensate for any Kay attenuator error.

H. Measure the output level of the filter and record the results on the test data sheet.

I. Using the Kay attenuator (compensated error) by substitution method, measure the gain steps at each of the gain settings shown on the test data sheet.

J. Repeat steps C through I for each occupied filter channel.

TEST 4 OVERLOAD LIGHT, ONSET
SPECIFICATION 20 VOLTS P-P (FULL-SCALE) NOMINAL

A. Set up the test equipment as shown in Fig. 5.2. (Connect the equipment to channel under test).

B. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	High Pass Channels: 01 x 1 Hz Low Pass Channels: 99 x 1 KHz

C. Adjust the Wavetek 143 generator to provide a 1 KHz sinewave at a level of 0 dBm.

D. Observe both overload indicators - they should be off.

E. Slowly increase the output level of the generator until the overload LED indicator of either pre-or post-gain goes on.

F. Observe the level reading on the AC voltmeter (input level for pre-gain and output level for post-gain) when the LED goes on.

G. Record the level on the test data sheet.

H. Increase the generator output level slowly until the other overload LED goes on.

I. Record this new level (observed on the other Voltmeter) on the test data sheet.

J. Repeat steps C through I for each occupied channel and record the results on the test data sheet.

TEST 5 PHASE MATCH TEST
SPECIFICATION ±4° MAXIMUM

A. Set up the equipment as shown in Fig. 5.3. (Connect equipment to channel under test).

B. Set the filter cutoff frequency (high or low pass filters) to 80 x 1 (80 Hz).

C. Set the pre-gain and post-gain to 0 dB.

D. Adjust the frequency synthesizer to provide a 0 dBm output at the cutoff dial frequency.

E. Measure the phase difference on each occupied channel and record the readings on the test data sheet.

NOTE: Near cutoff, the phase shift can exceed 360° and may result in the reading on the phase meter to be offset by 180°. Moving the 180°/360° toggle switch on the phase meter may shift the reading 180°. Since the reading is only used to measure phase match between channels, the absolute phase measurement is not important, only the phase difference.

F. Repeat steps B through E for each frequency shown on the test data sheet and record the readings for every occupied channel.

G. Subtract the lowest phase readings from the highest readings to determine the phase match. (Do not compare low pass to high pass filter readings).

H. Record the phase match on the test data sheet.

TEST 6 AMPLITUDE MATCH
SPECIFICATION ±0.5 dB MAXIMUM

A. Set up the test equipment as shown in Fig. 5.1. (Connect the equipment to channel under test).

B. Set the filter cutoff frequency to 80 x 1 (80 Hz).

C. Set pre-gain and post-gain to 0 dB.

D. Set the frequency synthesizer to the cutoff dial frequency and adjust the output to 0 dBm (at filter input).

E. Measure the filter output level at each occupied channel and record the results on the test data sheet.

F. Repeat steps B through E for each frequency shown on the test data sheet and record the readings for every occupied channel.

G. Subtract the lowest amplitude readings from the highest readings to determine the amplitude match. (Do not compare low pass to high pass filter readings).

H. Record the amplitude match on the test data sheet.

TEST 7 FULL SCALE SIGNAL
SPECIFICATION ± 10V into 5K Ohms

A. Set up the test equipment as shown in Fig. 5.4. (Connect equipment to channel under test).

B. Adjust the Wavetek 143 generator to provide a 1 KHz sinewave at a level of 30V P-P.

C. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	High Pass Channels: 01 x 1 Hz Low Pass Channels: 99 x 1 KHz

D. Adjust the scope to internal trigger and set the vertical sensitivity to 5V/DIV, DC coupled and centered.

E. Reduce the output level of the generator while observing the output signal on the oscilloscope.

F. Measure the output level at the point where signal clipping (distortion) disappears. This is the maximum undistorted level.

G. Record the peak to peak output on the test data sheet.

H. Repeat steps B through G for each occupied channel and record the results on the test data sheet.

TEST 8 DC OFFSET TEST

SPECIFICATION ± 50 mV @ 0 dB GAIN BETWEEN 15° and 40°C

A. Connect a short circuit BNC plug to the input of the channel under test.

B. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	High Pass Channels: 01 x 1 Hz Low Pass Channels: 99 x 1 KHz

C. Using the DVM, measure the DC offset voltage at the filter output.

D. Record the DC voltage on the test data sheet or refer to the DC offset adjustment procedure if required.

E. Repeat steps A through D for each occupied channel.

5.5.4 DC Offset Adjustment

This adjustment may be performed if the output DC level is determined to be out of specification limits. The adjustment should be performed after allowing at least 10 minutes for the instrument to warm up under power.

A. Remove the filter assembly from the System 716 frame.

B. Insert the PC extender card (P/N: 01.320.0795) into the channel position being tested.

C. Plug the filter assembly into the card extender.

D. Connect the digital multimeter to TP1 and ground.

E. Set the filter controls as follows:

Pre-Gain	dB	-	0
Post-Gain	dB	-	0
Cutoff Freq.	Hz	-	High Pass Channels: 01 x 1 Hz Low Pass Channels: 99 x 1 KHz

F. Adjust the Input DC offset control R116 to provide a 0 VDC ± .001 mV.

G. Check the voltage at TP1 for all pre-gain settings and readjust R116 for minimum voltage deviation between 0 and 40 dB gain.

H. Connect the digital multimeter to the output of the filter and measure the offset voltage.

I. Adjust the output DC offset control (R138) to provide minimum voltage at 0 dB gain settings. The maximum offset voltage at 0 dB gain should be less than ± 50 mV.

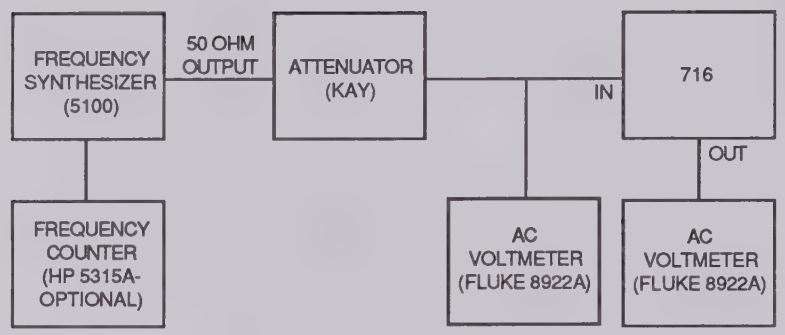


Fig. 5.1. Setup for Tests 1, 2, 3, and 6

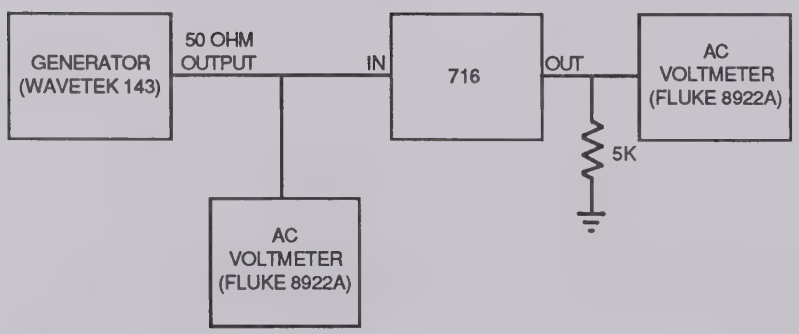


Fig. 5.2. Setup for Test 4

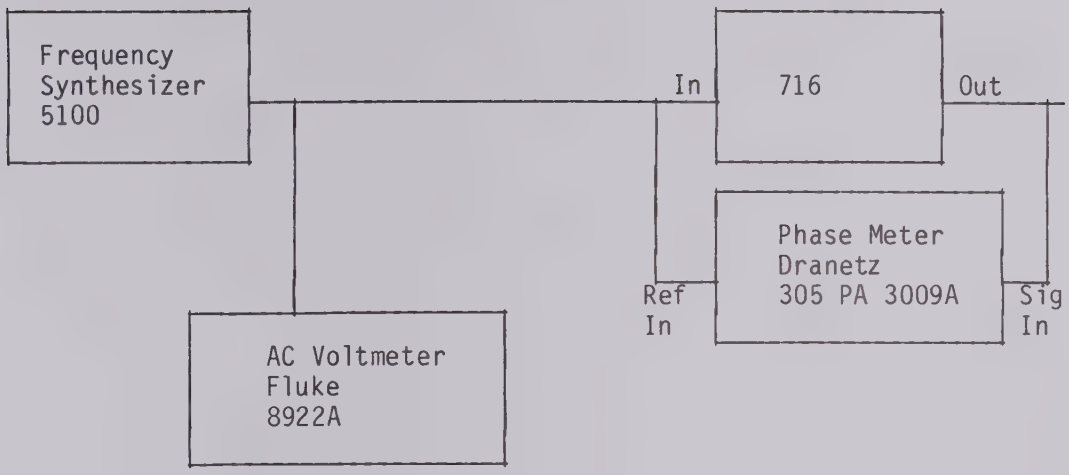


Fig. 5.3 Setup for Test 5

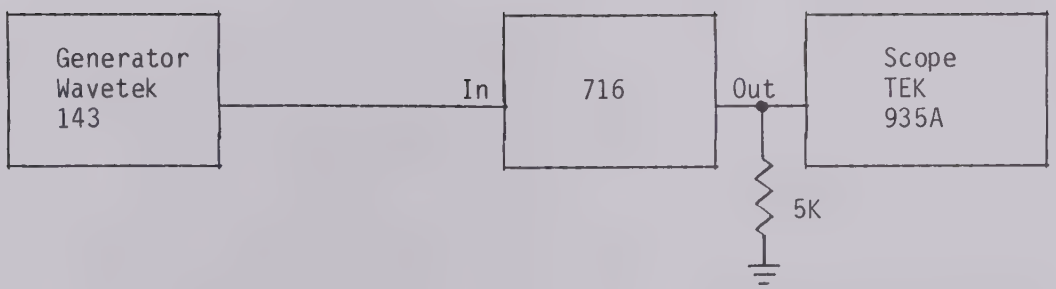


Fig. 5.4 Setup for Test 7

716 FILTER ASSEMBLY-TEST DATA SHEET

MODEL 02.004.0730 and 02.004.0735

DATE:_____

SERIAL NO:_____ TECH:_____

MODEL NO :_____ (004.0735 Low Pass) (004.0730 High Pass) APPROVED:_____

TEST 1 PASSBAND RIPPLE		TEST 2 CUTOFF FREQUENCY ACCURACY					
				Cutoff Frequency - Hz			
				High Pass Limits		Low Pass Limits	
Frequency Dial Setting	Ripple (0.8dB max)	Frequency Dial Setting	0730 HP	-0.6dB down	Nominal	-0.6 dB down	0735 LP
80 x 1	_____	80 x 1	____	77.2	80	82.8	____
40 x 10	_____	40 x 10	____	386	400	414	____
10 x 100	_____	10 x 100	____	965	1K	1.035K	____
20 x 100	_____	20 x 100	____	1.93K	2K	2.07K	____
10 x 1K	_____	10 x 1K	____	9.65K	10K	10.35K	____
		40 x 1K	____	38.6K	40K	41.4K	____
80 x 1K*	_____	80 x 1K	____	77.2K	80K	82.8K	____
99 x 1K*	_____	99 x 1K	____	95.5K	99K	102.5K	____

* 1.4 dB p-p max for High Pass

TEST 3
GAIN STEPS Spec = Gain Steps ±0.25dB Max from reference level

0 dB Pre-gain
0 dB Post-Gain _____dB Reference Level (+ 0.25 dB Max)

Pre-gain (Post-gain 0 dB)		Post-gain (Pre-gain 0 dB)	
10	_____dB	10	_____dB
20	_____dB	20	_____dB
30	_____dB		
40	_____dB		

TEST 4
OVERLOAD LIGHT - Operation - full scale, nominal 20 V P-P
(LED TURN ON) Pre-gain _____Vrms Post-gain _____Vrms (At output, into 5K Ohms)

TEST 5
PHASE TEST

Frequency Dial Setting	Phase Ref @ Dial Freq	Phase Match ±4° Max.
80 x 1		
40 x 10		
10 x 100		
20 x 100		
10 x 1K		
20 x 1K		
40 x 1K		
80 x 1K		
99 x 1K		

Note:To determine the phase match between channels, examine the phase readings at each of the occupied channels. Subtract the lowest reading from the highest at each of the dial settings shown, and record the information in the column to the left. (Do not match high pass to low pass channels.)

TEST 6
Amplitude Match

Frequency Dial Setting	Amplitude dB	Amplitude Match ±0.5 dB Max.
80 x 1		
40 x 10		
10 x 100		
20 x 100		
10 x 1K		
20 x 1K		
40 x 1K		
80 x 1K		
99 x 1K		

Note: To determine the amplitude match between channels, examine the amplitude readings at each of the occupied channels. Subtract the lowest reading from the highest at each of the dial settings shown, and record the information in the column to the left. (Do not match high pass to low pass channels.)

TEST 7
FULL SCALE SIGNAL

OUTPUT LEVEL ± 10 V P-P into 5K Ohms (Minimum)

INPUT - 1 KHz
_____V P-P

TEST 8
DC OFFSET (Input Shorted)

Gain at 0 dB	SPEC LIMITS
_____mV	± 50mV (15° to 40°C)

SECTION 6
PARTS AND SCHEMATICS

6-1. DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

6-2. ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and, if applicable, the function performed.

6-3. ERRATA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, errata pages are prepared to summarize the changes made and are inserted inside the shipping carton with this manual. If no such pages exist, the manual is correct as printed.

DRAWING	DRAWING NUMBER
Front Panel Assembly and Parts List	02-001-0705
Front Panel PCB Schematic	03-004-0705
Front Panel PCB Assembly	02-004-0705
Front Panel PCB Parts List	004.0705
Scanner Schematic	03-004-0710
Scanner Assembly	02-004-0710
Scanner Parts List	004.0710
Rear Panel Assembly	02-002-0795
Rear Panel Parts LIst	002.0795
Left Side Frame Assembly	02-002-6465
Left Side Frame Parts List	002.6465
Right Side Frame Assembly	02-002-6466
Right Side Frame Parts List	002.6466
Card Cage Assembly	02-002-0720
Card Cage Parts List	002-0720
Main Board Schematic	03-004-0720
Main Board Assembly and Parts List	02-004-0720

DRAWING	DRAWING NUMBER
High Pass Filter Schematic	03-004-0730
High Pass Filter Assembly	02-004-0730
High Pass Filter Parts List	004.0730
Low Pass Filter Schematic	03-004-0735
Low Pass Filter Assembly	02-004-0735
Low Pass Filter Parts List	004.0735
Power Supply Schematic	03-174-5106
IEEE Paddle Board Schematic	03-009-9785
IEEE Paddle Board Assembly and Parts List	02-009-9785

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LTR	ECO NO	CHANGE BY	APPD	DATE
E				

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PI
1	FRONT PANEL BD ASSY, 716			004 0705	1
NONE	PANEL, FRONT 716	300 0706	WVTK	300 0706	1
11	S TOG DPDT ON-ON RB	7201-SV2Q	C&K	340 2200	1
7	KNOB BAR LT/GRY ANALOG GAIN	RB-67-1-SD-ML	ROGAN	370 0771	2
5	KNOB DIAL 0-9 LT-GRY/BLK-MK			370 0772	2
9	KNOB MULT 1-1K LT-GRY/BLK-MK			370 0773	1
17	SHRINK TBG PLYFIN BLACK 3/4"			378 3620	8
NONE	M SCR ST ZN PHIL 6-32X1/4			381 6042	10

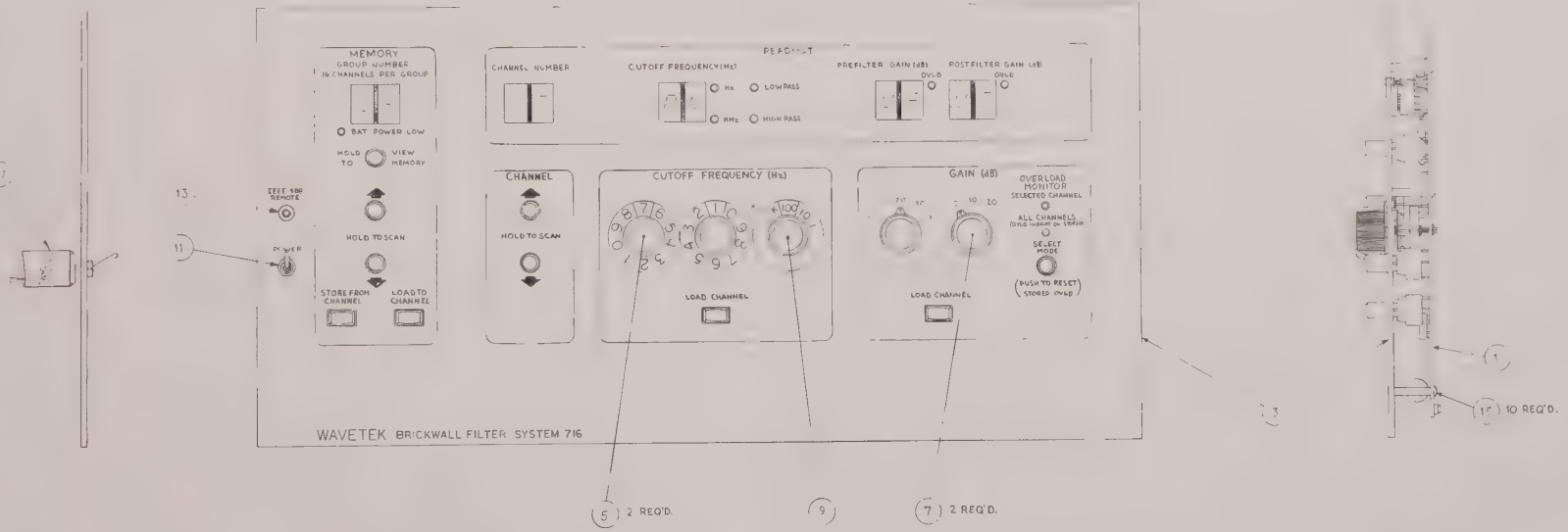
WAVETEK PARTS LIST

TITLE: PANEL ASSEMBLY FRONT 716

ASSEMBLY NO: 001 0705

REV: E

PAGE 1



NOTE ISLANDS SHOWN ABOVE ARE NOT RETAINED IN FINAL ARTWORK

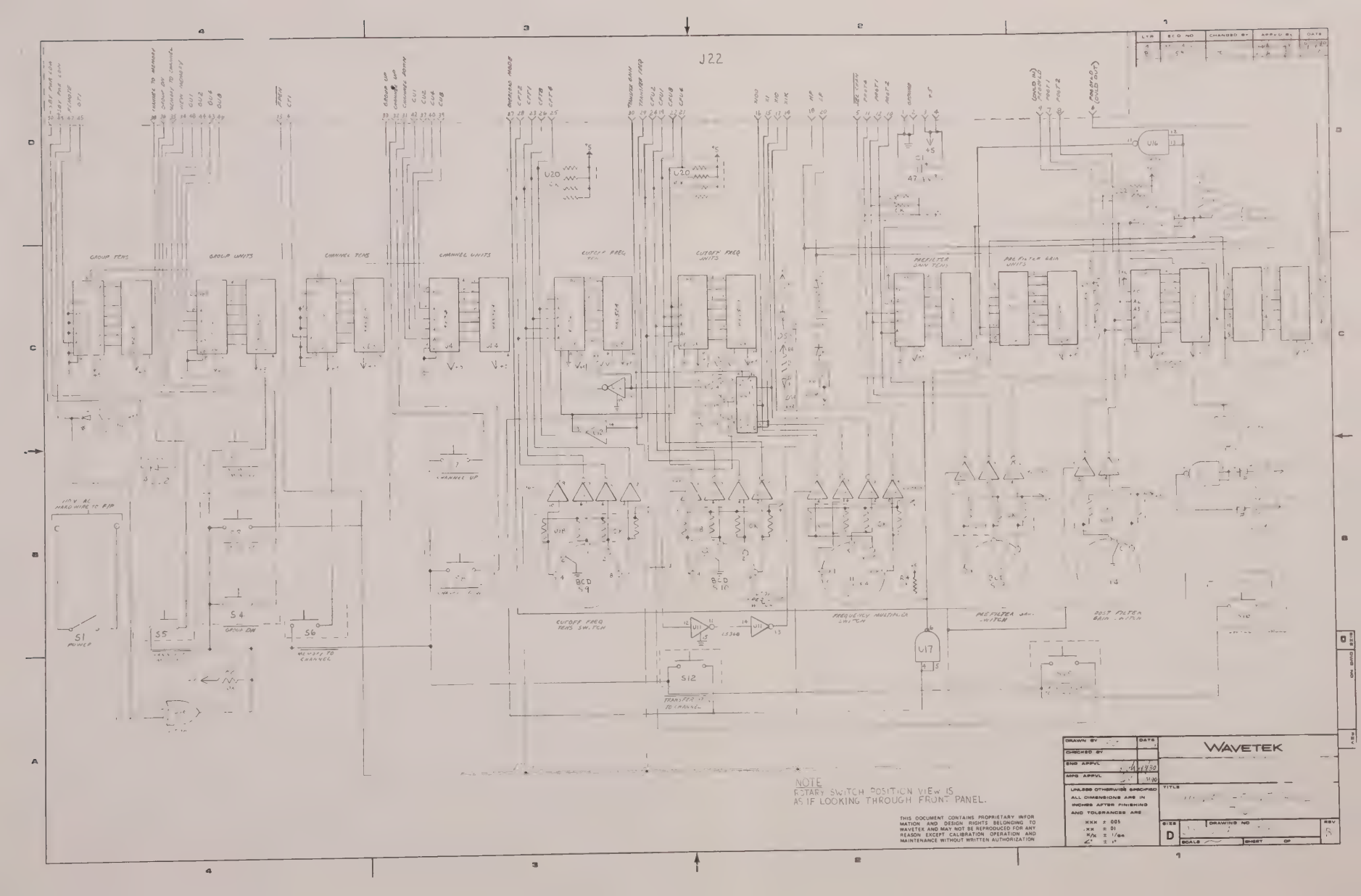
DRAWN BY TC	DATE 7/18/86	WAVETEK
CHECKED BY		
ENG APPVL	7/31/86	
MFG APPVL	7/31/86	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE: .XXX ± .005, .XX ± .01, X/X ± 1/64, ∠ ± 1°

TITLE: FRONT PANEL ASS'Y. (716)

SIZE D | DRAWING NO. 02-001-0705 | REV E

SCALE


J22
GROUP TENS
GROUP UNITS
CHANNEL TENS
CHANNEL UNITS
CUTOFF FREQ TENS
CUTOFF FREQ UNITS
PREFILTER GAIN TENS
PREFILTER GAIN UNITS
U16
U17
U20
U20
U4
U4
U12
U11
U11
U18
S1 POWER
S4 GROUP DN
S5
S6 REVERT TO CHANNEL
S12 TRANSFER TO CHANNEL
CHANNEL UP
BCD
BCD
CUTOFF FREQ TENS SW. FCN
FREQUENCY MULTIPLIER SWITCH
PREFILTER GAIN SWITCH
POST FILTER GAIN SWITCH
LS368
NOTE
ROTARY SWITCH POSITION VIEW IS
AS IF LOOKING THROUGH FRONT PANEL.
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DRAWN BY
CHECKED BY
ENG APPVL
MFG APPVL
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
XXX ± 005
.XX ± 01
FRAC ± 1/64
ANG ± 1°
WAVETEK
TITLE
SIZE D
DRAWING NO
REV
SCALE
SHEET OF

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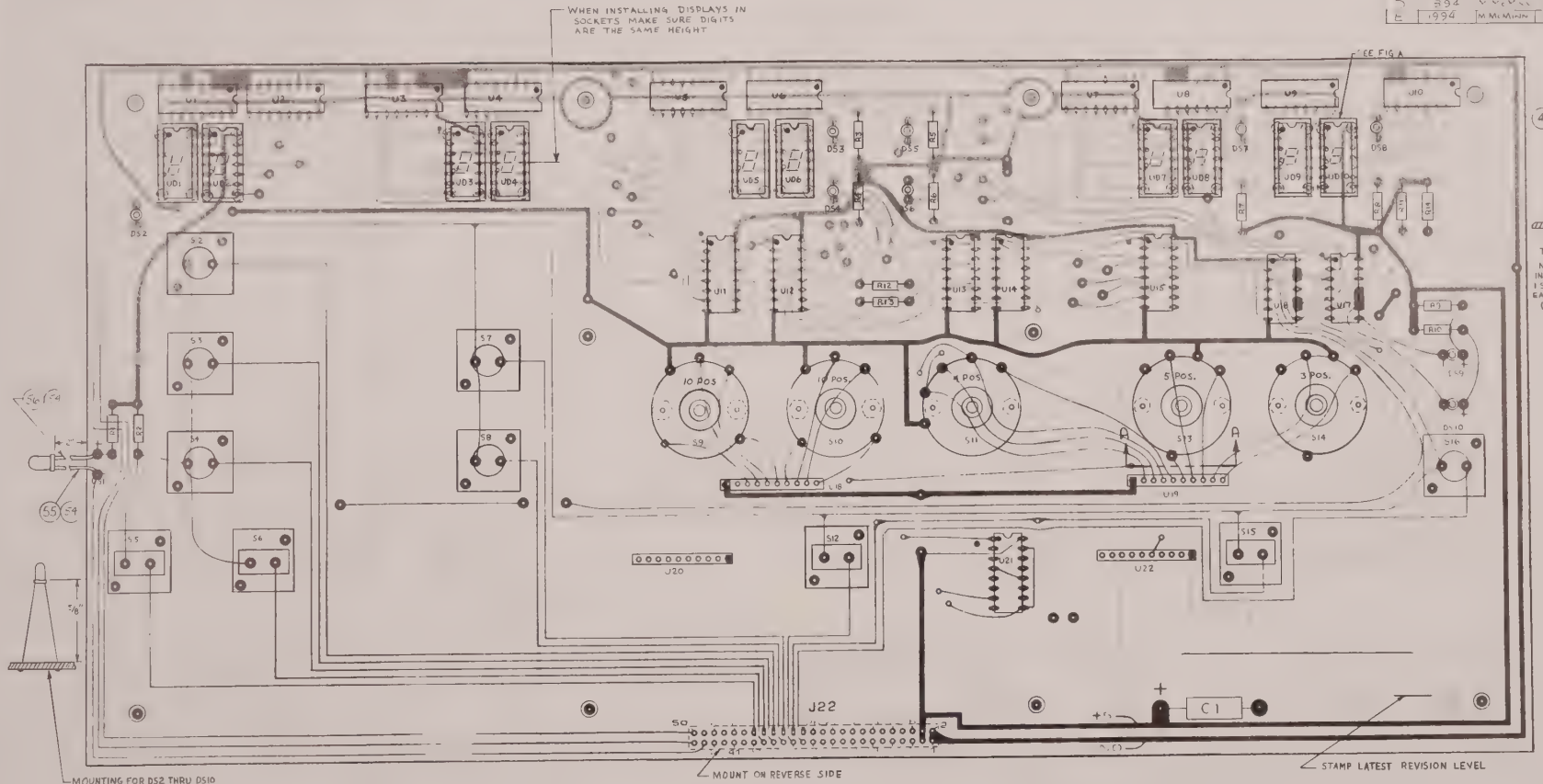
LTR	ECO NO	CHANGED BY	APPVD BY	DATE
A	RELEASE			
B	1159	TC		
C	1282	SD		
D	394	[illegible]		
E	1994	M McMinn		



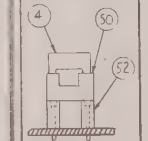
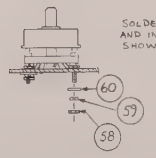


FIG A
TYP UD1 THRU UD10

NOTE.
INSTALL #50 WITH 1 SPACER #52 ON EACH CORNER.
(4 PER SOCKET)



SECTION A-A
(TYP S9, S10, S11, S13, S14)

SOLDER SWITCH TO BD AND INSTALL HDWR AS SHOWN

DRAWN BY	TC	DATE 2/7/86
CHECKED BY		
ENG APPVL		4/3/86
MFG APPVL		4/3/86

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
.XXX ± .005
.XX ± .01
FRACTIONS ± 1/64
ANGLES ± 1°

WAVETEK

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TITLE
FRONT PANEL PCE ASSY
(716)

SIZE	DRAWING NO	REV
D	02 004-0705	E

SCALE 2/1

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	ASSY PRE WAVE LOAD 716-0705	716-2517	WVTK	1208-00-2517	1
UD1 UD10 UD2 UD3 UD4 UD5 UD6 UD7 UD8 UD9	DISPLAY 7 SEG GRN 3 CA/LD	[illegible]	MDMSD	163 4002	10
DS10 DS3 DS4 DS5 DS6 DS9	LED GRN. MIN 2MCD@20. 60DVA	HLMP-1301	HP	171 1604	6
DS2 DS7 DS8	LED RED DIF O BMCD@20	RL209A	LITRI	171 1605	3
S12 S15 S16 S2 S3 S4 S5 S6 S7 S8	S PB SPST M O	DC-61-03	SHADW	341 1102	10
S11	S ROT 1P 4 POS 36 [illegible] PCMT	4849512106M1	SO	343 1041	1
S14	S ROT 1P 3 POS BCD PCMT	4886112126M1	SO	345 1032	1
S13	S ROT 1P 5 POS BCD PCMT	[illegible]	SO	345 1051	1
S10 S9	S ROT 10P BCD 36 DEG [illegible]	2APA01600432	CRL	345 1103	2
UD10A UD1A UD2A UD3A UD4A UD5A UD6A UD7A UD8A UD9A	SOCKET IC 14PIN DIP MP 2X	ICM-143-WA-TG	ROBMU	353 1401	10
J22	CONN TERM 50PIN DIL ST	929663-01-25	A/P	354 0021	1

WAVETEK PARTS LIST	TITLE: FRONT PANEL BD ASSY. 716	[illegible] NO. 004 0705	REV E
		PAGE 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
C1	CAP.ELECT. 47UF 20% 63V	47/63-81009	SIEM	109 6470	1
R1 R10 R12 R13 R3 R4 R5 R6 R7 R8 R9	RES.CFLM 150 OHM 5% 1/4W			116 1151	11
R11 R14 R2	RES.CFLM 10K OHM 5% 1/4W			116 3101	3
U1 U2 U3 U4 U5 U6 U7 U9	U LED DECOD/DRIVE/LATCH 9374	ME586N	SIG	120 4074	8
NONE	PC BD PREPPED 716-0709	716-2518	WVTK	1208-00-2518	1
U12	U QD 2 IN NAND BUFFER O/C	N7438N-8	SIG	122 7438	1
U11 U12 U13 U14 U15	U: HI BUS DRIV INV 3ST (LS368)	SN74LS368N	TI	125 0132	5
U21	U 4 ST LATCH (74LS375)	SN74LS375N-3	TI	125 0141	1
U17	U QUAD 2 IN NAND BUFFER O/C	SN74LS38N	TI	125 7438	1
U10 U8	RES.NETWORK. 150 OHM 2% X7	4114R-001-151	BOURN	128 1156	2
U18 U19 U20 U22	U PULL UP NET 10K 2% X9 SIP	110A103	AB	128 3104	4

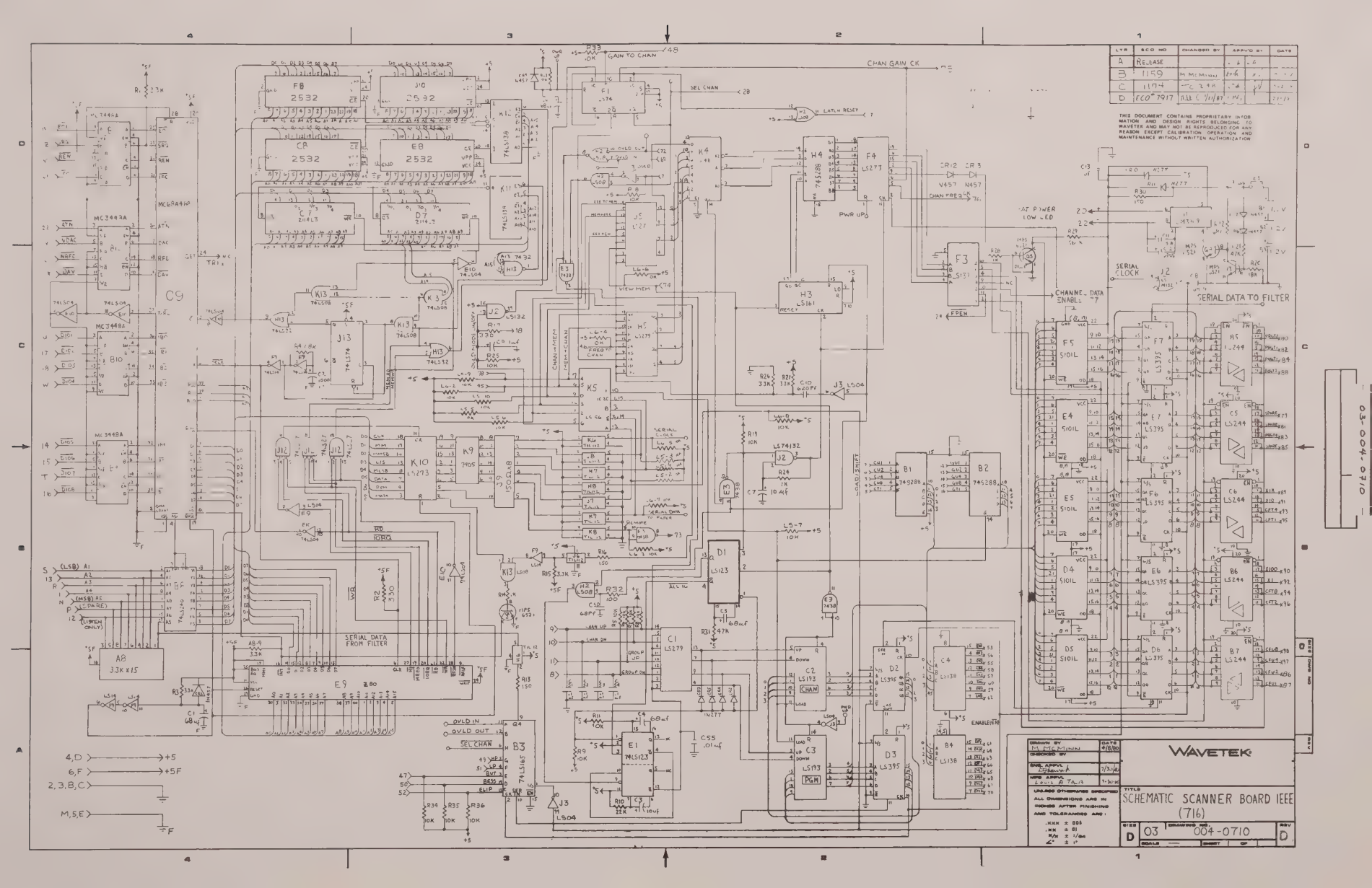
WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0705	ASSEMBLY NO: 1208-00-2517	REV
		PAGE 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
S16-A S2-A S3-A S4-A S7-A S8-A	[illegible] PUSHBUTTON [illegible]	05-370-0719	BURKY	370 0720	6
S12-A S15-A S5-A S6-A	KNOB PUSHBUTTON RECT	05-370-0719	BURKY	370 0722	4
NONE	SPCR NY 1/8D X 1/4L/ 06JID	901801301	MICRO	376.2106	40
NONE	WIRE 624 AWG STR BLACK	1124	MEICO	378.1704	2
NONE	WIRE 624 AWG STR RED	1124	MEICO	378.1724	2
NONE	SLVNG PLASTIC FBRGLS [illegible]			378.3181	1
NONE	NUT HEX SS 2-56X5/32 AF			387 2051	10
NONE	WASHER SPLT LK STNLS #2			388.1022	10
NONE	WASHER FLAT NYL #2X.250X.032			388.3020	10
NONE	LED	TIL-220	TI	4899-00-0004	1

WAVETEK PARTS LIST	TITLE: FRONT PANEL BD ASSY. 716	ASSEMBLY NO. 004 0705	REV E
		PAGE 2	

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE: PARTS LIST FRONT PANEL
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.020		
	DO NOT SCALE DWG		MODEL NO. 716 DWG NO. 004.0705 REV E
	SCALE		CODE IDENT 23338 SHEET 1 OF 1

NOTE UNLESS OTHERWISE SPECIFIED


REVISIONS
LTR | ECO NO | CHANGED BY | APPVD BY | DATE
A | RELEASE | | | -
B | 1159 | M. McMINN | | -
C | 1174 | | | -
D | ECO 7917 | ALL | | 2/1/13
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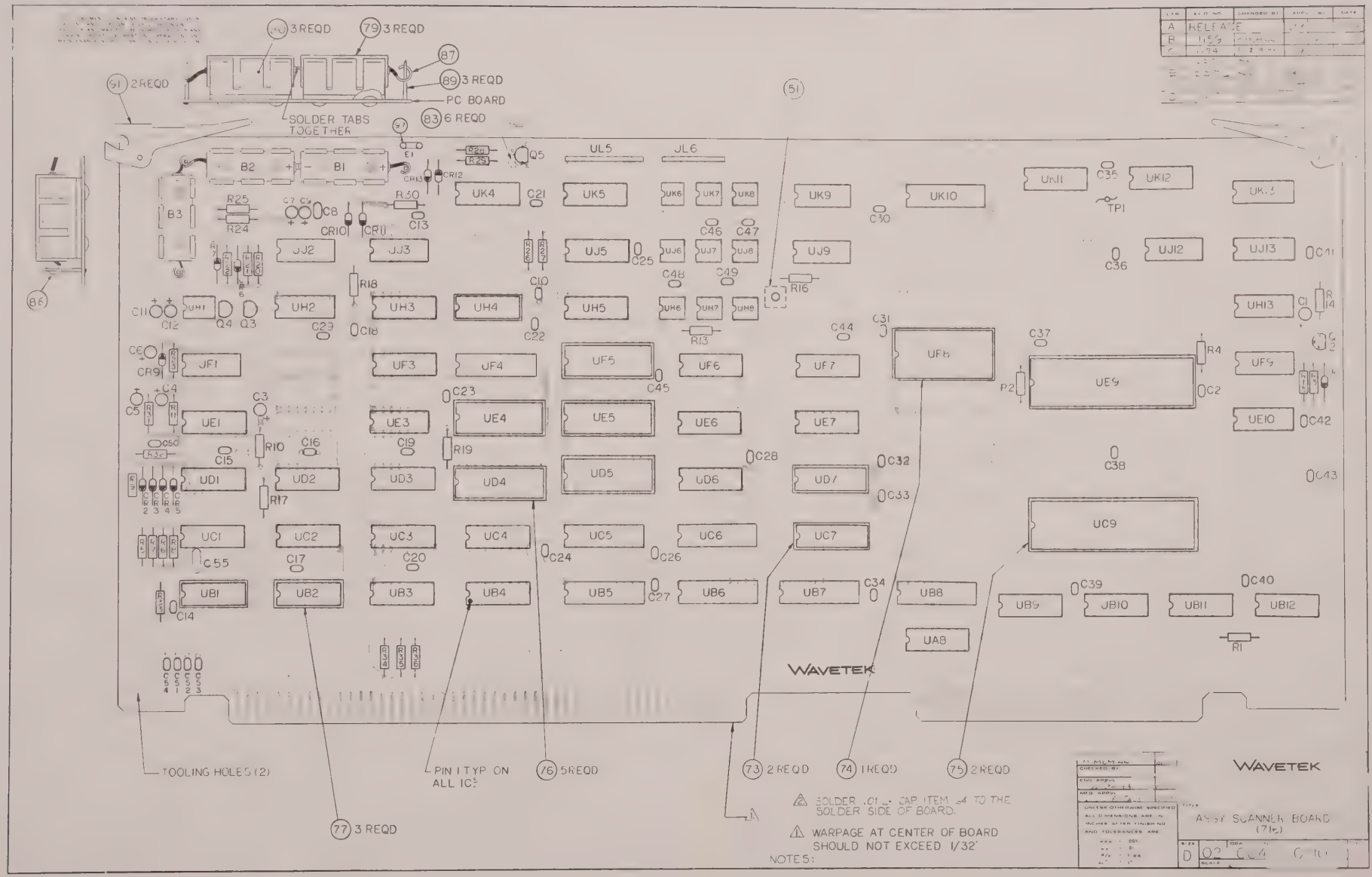
GAIN TO CHAN
CHAN GAIN CK
SEL CHAN
LATCH RESET
PWR UP
SERIAL CLOCK
SERIAL DATA TO FILTER
CHANNEL DATA ENABLE
SERIAL DATA FROM FILTER
DRAWN BY M. McMINN DATE 4/8/80
CHECKED BY
ENG APPVL 7/3/80
MFG APPVL 7-30-80
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE: .XXX ± 005 .XX ± 01 X/X ± 1/64 ∠° ± 1°
WAVETEK
TITLE SCHEMATIC SCANNER BOARD IEEE (716)
SIZE D 03 DRAWING NO. 004-0710 REV D
SCALE — SHEET OF
004-0710


3 REQD
3 REQD
87
89 3 REQD
PC BOARD
83 6 REQD
91 2 REQD
SOLDER TABS TOGETHER
97
51
B2
B1
B3
CR12
CR13
Q5
UL5
UL6
UK4
UK5
UK6
UK7
UK8
UK9
UK10
UK11
UK12
UK13
C21
C30
C35
TP1
R30
R25
R24
C7
C8
CR10
CR11
C13
C46
C47
C48
C49
UJ2
UJ3
UJ5
UJ6
UJ7
UJ8
UJ9
UJ12
UJ13
C25
C36
C41
C10
R16
R18
C11
C12
UH1
UH2
UH3
UH4
UH5
UH6
UH7
UH8
UH13
Q4
Q3
C29
C18
C22
R13
C44
C31
C37
R4
C6
CR9
C9
JF1
UF3
UF4
UF5
UF6
UF7
UF8
UF9
C45
P2
UE9
C2
C4
C5
C3
C23
UE1
UE3
UE4
UE5
UE6
UE7
UE10
C42
C50
C15
R10
C16
C19
R19
C28
C32
C38
C43
UD1
UD2
UD3
UD4
UD5
UD6
UD7
C33
R17
UC1
UC2
UC3
UC4
UC5
UC6
UC7
UC9
C55
C17
C20
C24
C26
UB1
UB2
UB3
UB4
UB5
UB6
UB7
UB8
UB9
UB10
UB11
UB12
C14
C27
C34
C39
C40
UA8
R1
WAVETEK
TOOLING HOLES (2)
PIN 1 TYP ON ALL IC'S
76 5 REQD
77 3 REQD
73 2 REQD
74 1 REQD
75 2 REQD
⚠ SOLDER .01 µF CAP ITEM A TO THE SOLDER SIDE OF BOARD.
⚠ WARPAGE AT CENTER OF BOARD SHOULD NOT EXCEED 1/32"
NOTES:
WAVETEK
ASSY SCANNER BOARD (71E)
D
02 004 C
SCALE

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR PART-NO	MFGR	WAVETEK NO	QTY/PT
C55	CAP. MONO. .01UF +80 -20% 50V	SR215E103ZAT	AVX	100 3103	1
C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33 C34 C35 C36 C37 C38 C39 C40 C41 C42 C43 C44 C45 C46 C47 C48 C49 C51 C52 C53 C54	CAP. MONO. 0 1UF 50V	SR215E104ZAT	AVX	100 4102	41
C50 C8	CAP FX VAL DP MICA 68PF 5% -20+100PPM/C BODE	CM05ED680JO3	CDE	101 0680	2
C10	CAP MICA FX VAL DIP 620PF 5% 0 TO+70PPM/C BODE	CD15FC621JO3	CDE	101 1620	1
C2	CAP MICA FX VAL DIP 1000PF 5% 0 TO70PPM/C100V	CD15FA102JO3	CDE	101 2100	1
C9	CAP. TANT. 1 0UF 20% 35V	T368A105M035AS	KEMET	109 5100	1
C3 C7	CAP. TANT. 10UF 20% 20V	T368B106M025A9	KEMET	109 6100	2
C1 C11 C12 C4 C9 C6	CAP. TANT. 68UF 20% 6V	T368B68M006AS	KEMET	109 6480	6
R32	RES. CFLM 100 OHM 5% 1/4W	CF1/4-100OHM. 5%	STKPL	116 1101	1

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
UB10 UB11 UB12 UB9	U IEEE BUS DRIVER (MC3448AL)	MC3448AL	MOT	120 4448	4
UH6 UH7 UH8 UJ6 UJ7 UJ8 UK6 UK7 UK8	U OPTO-ISOLATOR (TIL-112)	TIL-112	TI	120 9112	9
UH1	U LED FLASHER (LM3909)	LM3909N	NSC	120 9909	1
NONE	ASSY, PC BD PREPPED 716-0710	716-2522	WVTK	1208-00-2522	1
UK9	U HEX INVERTER (O/C OUT)	DM7405N/AT	NSC	122 7405	1
UE3	U QD 2 IN NAND BUFFER O/C	N7438N-B	SIG	122 7438	1
UD1 UE1	U DL MNSTBL MULTVIB (74LS123)	SN74LS123N-3	TI	125 0107	2
UC2 UC3	U 4 BT BIN U/D CTR (74LS193)	SN74LS193NDS	RAYTH	125 0111	2
UB4 UC4 UK11 UK12	U 3 TO 8 LINE DECOD (74LS138)	SN74LS138NDS	MOT	125 0115	4
UF3	U DL 2TO4 LN DECOD 74LS139	DM74LS139N/A+	NSC	125 0116	1
UH3	U 4 BT BIN SYNC CNT (74LS161)	74LS161N/B	SIG	125 0118	1

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 3

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
UJ12	U TRIPLE 3IN NOR GATE	SN74LS27N-3	TI	125 7427	1
UH13	U QUAD 2 IN OR GATE	N74LS32N-B	SIG	125 7432	1
UF1 UJ13	U DUAL TYPE D FLIP FLOP	N74LS74N-B	SIG	125 7474	2
UJ9	RES. NETWORK, 150 OHM 2% X7	4114R-001-151	BOURN	[illegible] 1156	1
UA8	U PULL UP NET 3 3K 2% X15	661-1-3 3K	BECK	[illegible] 2331	1
UL5	U PULL UP NET 10K 2% X9 SIP	110A103	AB	128 3104	1
UL6	U PULL UP NET 10K 2% X7 SIP	4308R-101-103	BOURN	128 3105	1
CR10 CR11 CR2 CR3 CR4 CR5	GER 120PIV 100MA (1N277)			132 0277	6
CR1 CR12 CR13 CR6 CR7 CR9	SL LW LK 70PIV 200MW (1N457)			132 0457	6
Q2 Q3 Q4 Q5	9 BIL NPN (MPSA521)	MPSA521	MOT	135 6521	4
NONE	SOCKET IC 16PIN DIP ST	ICN-163-S3-G	ROBMU	353 1604	3
NONE	SOCKET IC 18PIN DIP ST	ICN-183-S3-G	ROBMU	353 1801	2

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 5

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R13 R16 R30	RES. CFLM 150 OHM 5% 1/4W			116 1151	3
R17 R2	RES. CFLM 330 OHM 5% 1/4W	CF1/4-330OHM. 5%	STKPL	116 1331	2
R14 R24 R28	RES. CFLM. 1 0K OHM 5% 1/4W	CF-071K-5%	DALE	116 2101	3
[illegible]	RES. CFLM 1 8K OHM 5% 1/4W			116 2181	1
R1 R15 R26 R27 R3	RES. CFLM 3 3K OHM 5% 1/4W			116 2331	5
R11 R18 R19 R23 R25 R33 R34 R35 R36 R5 R6 R7 R8 R9	RES. CFLM 10K OHM 5% 1/4W			116 3101	14
R20	RES. CFLM 18K OHM 5% 1/4W			116 3181	1
R10	RES. CFLM 22K OHM 5% 1/4W			116 3221	1
R21 R31	RES. CFLM 47K OHM 5% 1/4W			116 3471	2
R22	RES. CFLM 68K OHM 5% 1/4W			116 3681	1
R29	RES. CFLM 560K OHM 5% 1/4W			116 4561	1

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
UC1 UH5 UJ5	U QD S-R LATCH (74LS279)	74LS279N/P3	TI	125 0129	3
UF4 UK10	U OCT D-FLIP W/CLR (74LS273)	SN74LS273N-B	TI	125 0139	2
UD2 UD3 UD6 UE6 UE7 UF6 UF7	U 4 BT SHIFT REG 3-ST 74LS395	74LS395N/P3	TI	125 0143	7
UB8	U OCT BUF INV 3-ST (74LS240)	SN74LS240N 3	TI	125 0144	1
UJ2	U QD 2IN NAND SMT TQR (LS132)	74LS132NDS	SIG	125 0148	1
UB5 UB6 UB7 UC5 UC6	U OCT BUF 3-ST (74LS244)	SN74LS244N-B	SIG	125 0153	5
UK4	U 8-3 PRIORITY ENCOD (LS148)	SN74LS148N/P3	TI	125 0155	1
UK5	U DUAL 2-4 DEMUX O/C (LS156)	DM74LS156N	NSC	125 0156	1
UB3	U 8BT SHFT REG PISO (74LS165)	SN74LS165NDS	MOT	125 0157	1
UE10 UJ3	U HEX INVERTER	N74LS04N-B	SIG	125 7404	2
UH2 UK13	U QUAD 2 IN AND GATE	SN74LS08N-B	SIG	125 7408	2
UF9	U HEX SMT TRGR	74LS14N/DS	MOT	125 7414	1

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 4

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	SOCKET IC 22PIN DIP ST	ICN-224-S4-TG	ROBMU	353 2201	5
NONE	SOCKET IC 24PIN DIP ST	ICN246-34G	ROBMU	353 2402	1
NONE	SOCKET IC 40PIN DIP ST	ICN-406-S4-G	ROBMU	353 4001	2
B1	CONN TERM TEST POINT	61134-1	AMP	354 0027	1

WAVETEK PARTS LIST	TITLE: ASSY PRE WAVE LOAD 716-0710	ASSEMBLY NO: 1208-00-2521	REV

PAGE 6

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE
MATERIAL	PROJENGR	
	RELEASE APPROV	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1° XX ±.030	
	DO NOT SCALE DWG	
	SCALE	

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: PARTS LIST SCANNER

MODEL NO	[illegible]	REV
716	004.0710	G
CODE IDENT 23338	SHEET 1 OF 2	

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	PROM SET PGMD 716			021 9018	1
NONE	ELECT SCHEMATIC SCANNER BD-IEEE (716)	03 004 0710	WVTK	03 004 0710	1
C56	CAP, MOND. .01UF +80 -20% 50V	SR215E103ZAT	AVX	100 3105	1
NONE	ASSY PRE WAVE LOAD 716-0710	716-2521	WVTK	1208-00-2521	1
UC7 UD7	U RAM 1KX4 STATIC (2114L3)			129 3017	2
UD4 UD5 UE4 UE5 UF5	U RAM 256X4 STATIC CMOS	MCM5L101C45	MOT	129 3023	5
[illegible]	MICRO PROCESSOR (2 MHZ, Z80)	MK3880N	MOSTK	129 3201	1
UC9	MC6840B-MH	MC6840BP	MOT	129 3202	1
B1 B2 B3	BATTERY NICAD	P15N-F1	PANAS	161 1000	3
97	CONN. PLUG SHORTING (LOW PROF)	4612072-01-03-10	CTC	352 0202	1
[illegible]	SOCKET JMPR (USE W/352 0202)	4303327-01-0300	CTC	353 0104	2
[illegible]	CONN TERM PIN .025 WW (NAIL)	W98-025-360-GH-GOLD	A/S	354 0003	3

WAVETEK PARTS LIST | TITLE: SCANNER ASSY, 716 | ASSEMBLY NO: 004 0710 | REV: 0

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
91	EJECTOR PC, 716	NE3001-W	ELESP	364 0403	2
51	SPACER NYL SNAP-BTN (MB1-156)	MB-1-156	P&MC	376 2109	1
[illegible]	WIRE #22 AWG BON BLACK	1522	WEICO	378 1603	1
87	WIRE #22 AWG BON RED	1522	WEICO	378 1623	1

WAVETEK PARTS LIST | TITLE: SCANNER ASSY, 716 | ASSEMBLY NO: 004 0710 | REV: 0

REMOVE ALL BURRS AND BREAK SHARP EDGES | DRAWN | DATE

MATERIAL | PROJ/ENGR | RELEASE APPROV

FINISH WAVETEK PROCESS | TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1° XX ± .030 | DO NOT SCALE DWG | SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: PARTS LIST SCANNER

MODEL NO: 716 | DWG NO: 004 0710 | REV: G

CODE IDENT: 23338 | SHEET 2 OF 2

NOTE UNLESS OTHERWISE SPECIFIED

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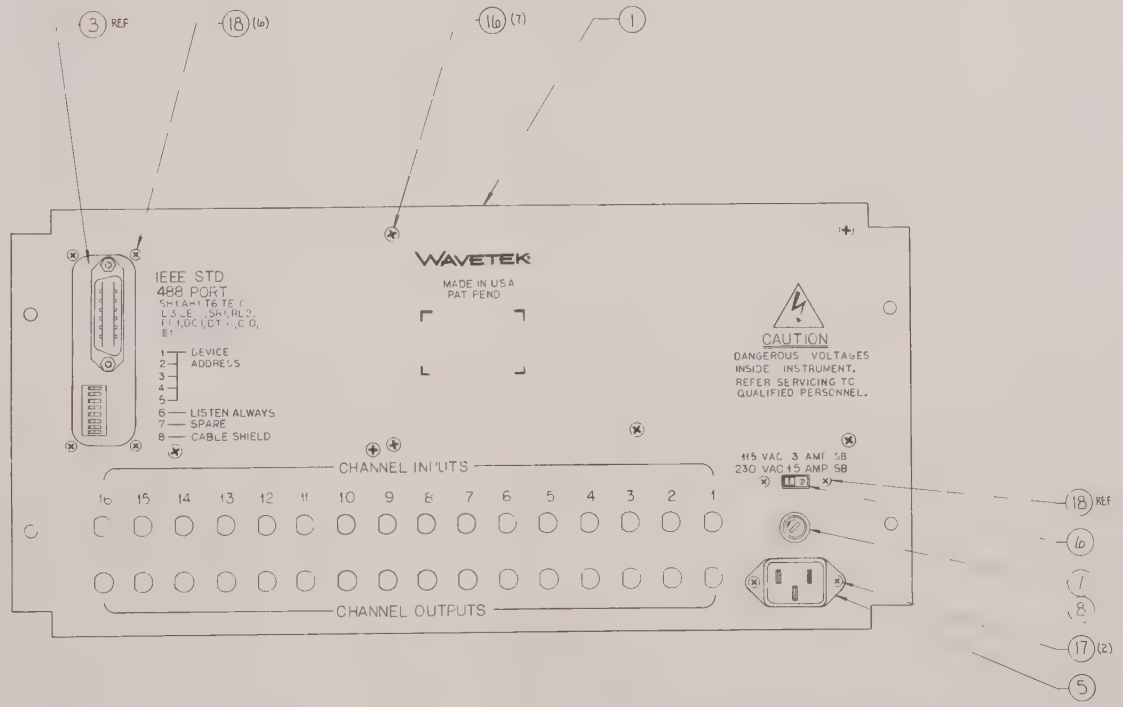
LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
A	RELEASE		[illegible] LAT	7-10-86
B	1155		[illegible] RJV	10/21/87
C	7890	MC 11/9/87		
D	B2216	[illegible] 12, 87		
E	9296	MC 3/31/88	RBG	4/15/91



DRAWN BY [illegible]	DATE 11/14/86	WAVETEK SAN DIEGO, CALIFORNIA
CHECKED BY [illegible]	7/24/91	
ENG APPV'L [illegible]	7/24/91	
MFG APPV'L [illegible]	11/11/86	

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ± 005
.XX ± 01
X/n ± 1/64
∠° ± 1°

TITLE: REAR PANEL ASSEMBLY (716)

SIZE D | DRAWING NO. 02-002-0795 | REV E | SCALE 1

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
J	CABLE ASSY IEEE INTERFACE 716			009 9793	1
C1	CAP,PLSTR, 10UF 10% 600V	DMT6P1	C-D	105 4100	1
5	FILTER POWER LINE 3A	3EF1	CORCM	165 3001	1
8	FUSE 3AG 3A SB 250V	313003	LITFU	165 4014	1
2	POWER SUPPLY SWITCHER, A/P	174 5006	WVTK	174 5106	1
NONE	SUPER KIT	2500-0716-02	WVTK	2500-0716-02	1
19	LOCKWASHER, INTERNAL STAR, PLATED, #6	#6 LOCKWASHER	CMRCL	2800-24-6000	-
1	PANEL REAR 716			307 0605	1
4	SHIELD POWER SUPPLY, 716			307 0924	1
6	SLIDE SW 115-230 SEL, DPDT, SHORT BAR INSTALLED	46256-LFR	SWCFT	342 2204	1
7	FUSE HOLDER MINI 3	031 1653/031 1666	SCHUR	351 9951	1
9	LUG SOLDER ANGLED #6	1416-6	SMITH	359 0006	1
14	WIRE #18 AWG STR	1118/19	WEICO	370 1404	7

WAVETEK PARTS LIST | TITLE: PANEL ASSY REAR 716 | ASSEMBLY NO: 002 0795 | REV: E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
	BLACK				
13	WIRE #18 AWG STR GREEN	1857/19	ALPHA	370 1454	2
18	M SCR ST ZN 4-40 X 3/8 PH			381 4062	6
17	M SCR ST ZN PH 4-40 X 1/2 PH			381 4082	2
16	M SCR ST ZN PHIL 6-32X1/4			381 6042	7
15	M SCR ST ZN PH 6-32X3/8 PH			381 6062	2
22	NUT HX ST ZN 4-40X1/4 AF			387 4080	4
21	NUT HX ST ZN 6-32X1/4 AF			387 6080	2
20	WASHER INT LK STL ZN			388 1040	4
12	SLEEVING, 200A	TFT-200-20	ALPHA	6001-12-0000	3
23	SLEEVING, SHRINKABLE, 1 1/2 IN	QPO-135.1 1/2	RMTEK	6001-20-2400	1.5
11	SHRINK, CLEAR, 3/4	FP-301-3/4	ELCHC	6001-21-2000	1.5
10	SHRINK, CLEAR 1	FP-301-1	ELCHC	6001-21-6000	8

WAVETEK PARTS LIST | TITLE: PANEL ASSY REAR 716 | ASSEMBLY NO: 002 0795 | REV: E

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES | MATERIAL | FINISH WAVETEK PROCESS | DRAWN | DATE | PROJ ENGR | RELEASE APPROV | TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1° XX ± .030 | DO NOT SCALE DWG | SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: PARTS LIST REAR PANEL

MODEL NO: 716 | DWG NO: 002.0795 | REV: E

CODE IDENT: 23338 | SHEET 1 OF 1

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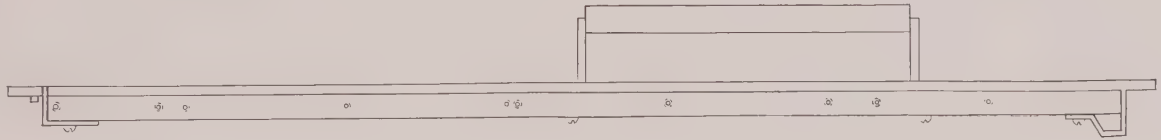
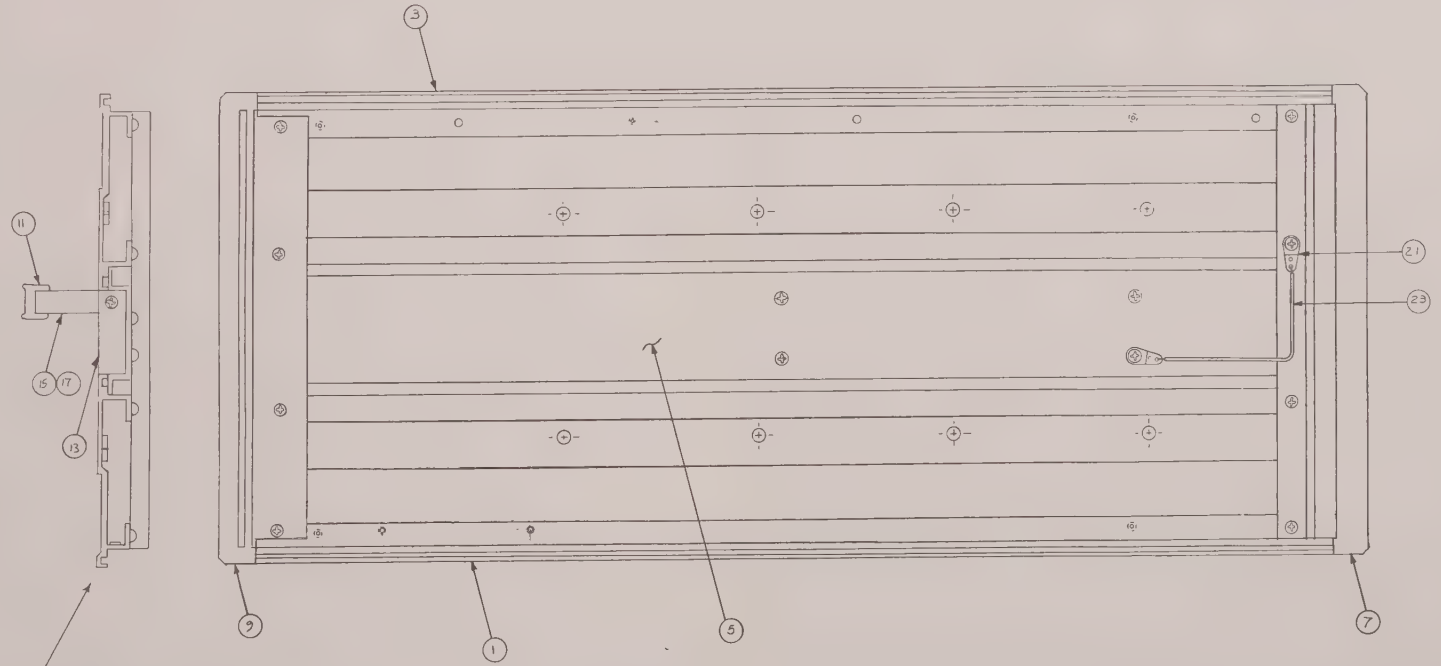
LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE			
B	825			
C	841			
D	1130			
E	1702			





THIS VIEW SHOWN WITH ITEM 9 OMITTED FOR CLARITY

DRAWN BY	T.H.	DATE 6/17
CHECKED BY		
ENG APPVL		7-27
MFG APPVL		7-29

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

WAVETEK

TITLE: SIDE FRAME ASSY (LEFT)

SIZE D | DRAWING NO. 02-002-6465 | REV E

SCALE 1/1

SIZE D | DWG NO 02-002-6465 | REV E

A4.35

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	SIDE PANEL TL-BR 512	MP-40322C	BUKEY	307 0500	1
NONE	SIDE PANEL BL-TR 512	MP-40321D	BUKEY	307 0501	1
NONE	SIDE PANEL CENTER, LEFT 512	MP-40320	BUKEY	307 0502	1
NONE	TRIM FRONT VERT 512	MP40282-4	BUKEY	307 0902	1
NONE	TRIM REAR VERT 512	MP40316	BUKEY	307 0903	1
NONE	HANDLE 512 CASE	MP40325	BUKEY	307 0904	1
NONE	HANDLE END 512 CASE	MP40324	BUKEY	307 0905	2
NONE	HANDLE MTG BAR LFT, 512 CASE	MP40323-2	BUKEY	307 0906	1
NONE	HANDLE MTG BAR RT, 512 CASE	MP40323-1	BUKEY	307 0907	1
NONE	LUG SOLDER ANGLED #6	1416-6	SMITH	359 0006	2
NONE	WIRE #18 AWG STR BLACK	1118/19	WEICO	378 1404	4
NONE	M SCR BT ZN PHIL 6-32X1/4			381 6042	14

WAVETEK PARTS LIST | TITLE: SIDE FRAME ASSY LEFT | ASSEMBLY NO: 002 6465 | REV: E

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE: PARTS LIST SIDE FRAME ASSEMBLY LEFT
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ±1° XX ± .030		
	DO NOT SCALE DWG		MODEL NO: 716 | DWG NO: 002 6465 | REV: E
	SCALE		CODE IDENT: 23338 | SHEET 1 OF 1

NOTE UNLESS OTHERWISE SPECIFIED

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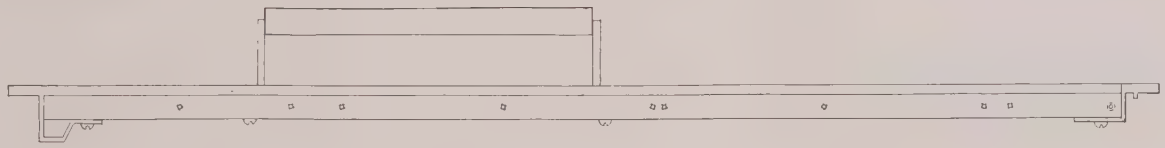
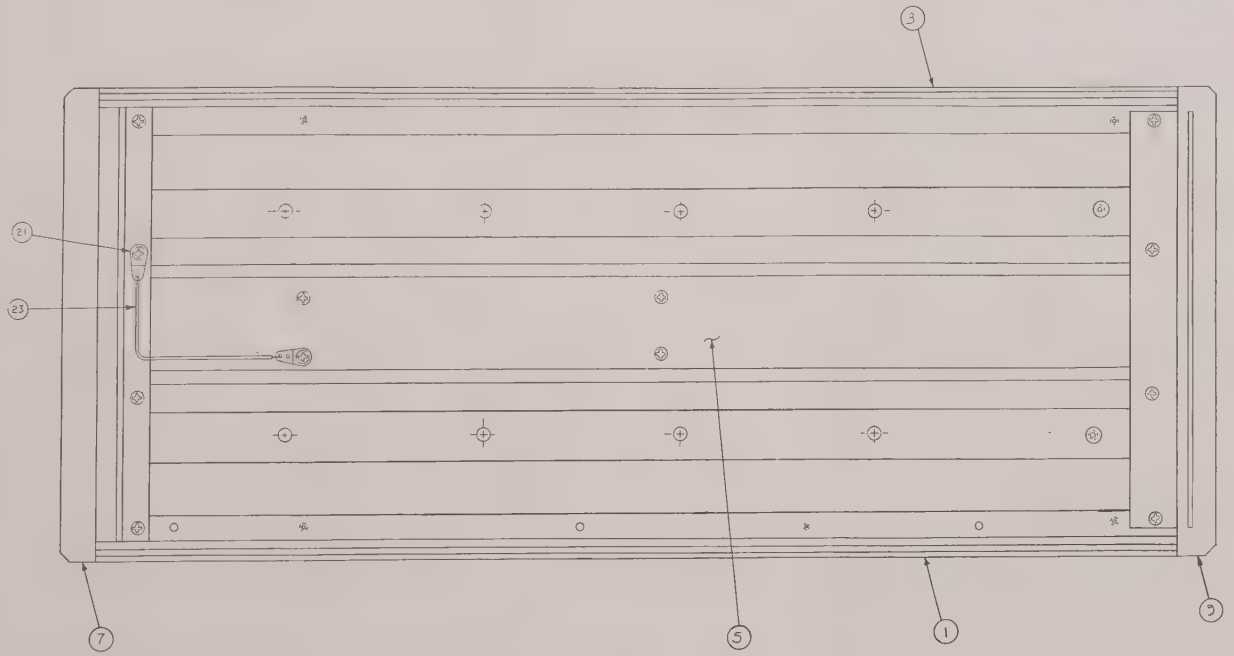
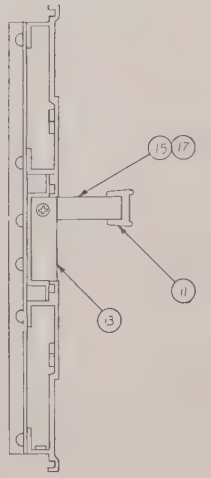
LTR	ECO NO	CHANGED BY	APPVD BY	DATE
A	[illegible]			
B	1450			
C	1702			







THIS VIEW SHOWN WITH ITEM 9 OMITTED FOR CLARITY

DRAWN BY	DATE 6/15	WAVETEK
CHECKED BY		
ENG APPVL.	1/14	
MFG APPVL.	2	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
FRACTIONS ± 1/64
ANGLES ± 1°

TITLE: SIDE FRAME ASSY. (RIGHT)

SIZE D | DRAWING NO. 02 002-6466 | REV C

SCALE 1:1

02 002-6466 C

A697

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
NONE	SIDE PANEL TL-BR 512	MP-40322E	BUKEY	307 0500	1
NONE	SIDE PANEL BL-TR 512	MP-40321D	BUKEY	307 0501	1
NONE	SIDE PANEL CENTER, RIGHT 512	MP40320-1	BUKEY	307 0503	1
NONE	TRIM FRONT VERT 512	MP40282-4	BUKEY	307 0902	1
NONE	TRIM REAR VERT 512	MP40316	BUKEY	307 0903	1
NONE	HANDLE 512 CASE	MP40325	BUKEY	307 0904	1
NONE	HANDLE END 512 CASE	MP40324	BUKEY	307 0905	2
NONE	HANDLE MTG BAR LFT, 512 CASE	MP40323-2	BUKEY	307 0906	1
NONE	HANDLE MTG BAR RT, 512 CASE	MP40323-1	BUKEY	307 0907	1
NONE	LUG SOLDER ANGLED #6	1416-6	SMITH	359 0006	2
NONE	WIRE 818 AWG STR BLACK	1118/19	WEICO	378 1404	4
[redacted]	M SCR ST ZN PHIL 6-32X1/4			381 6042	14

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO	REV
	SIDE FRAME ASSY: RIGHT	002 6466	C

PAGE 1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE
MATERIAL	PROJ ENGR	
	RELEASE APPROV	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1° XX ± .030	
	DO NOT SCALE DWG	
	SCALE	

WAVETEK San Diego, California

TITLE
PARTS LIST
SIDE FRAME ASSEMBLY
RIGHT

MODEL NO	DWG NO	REV
716	002 6466	C

CODE IDENT 23338 SHEET 1 OF 1

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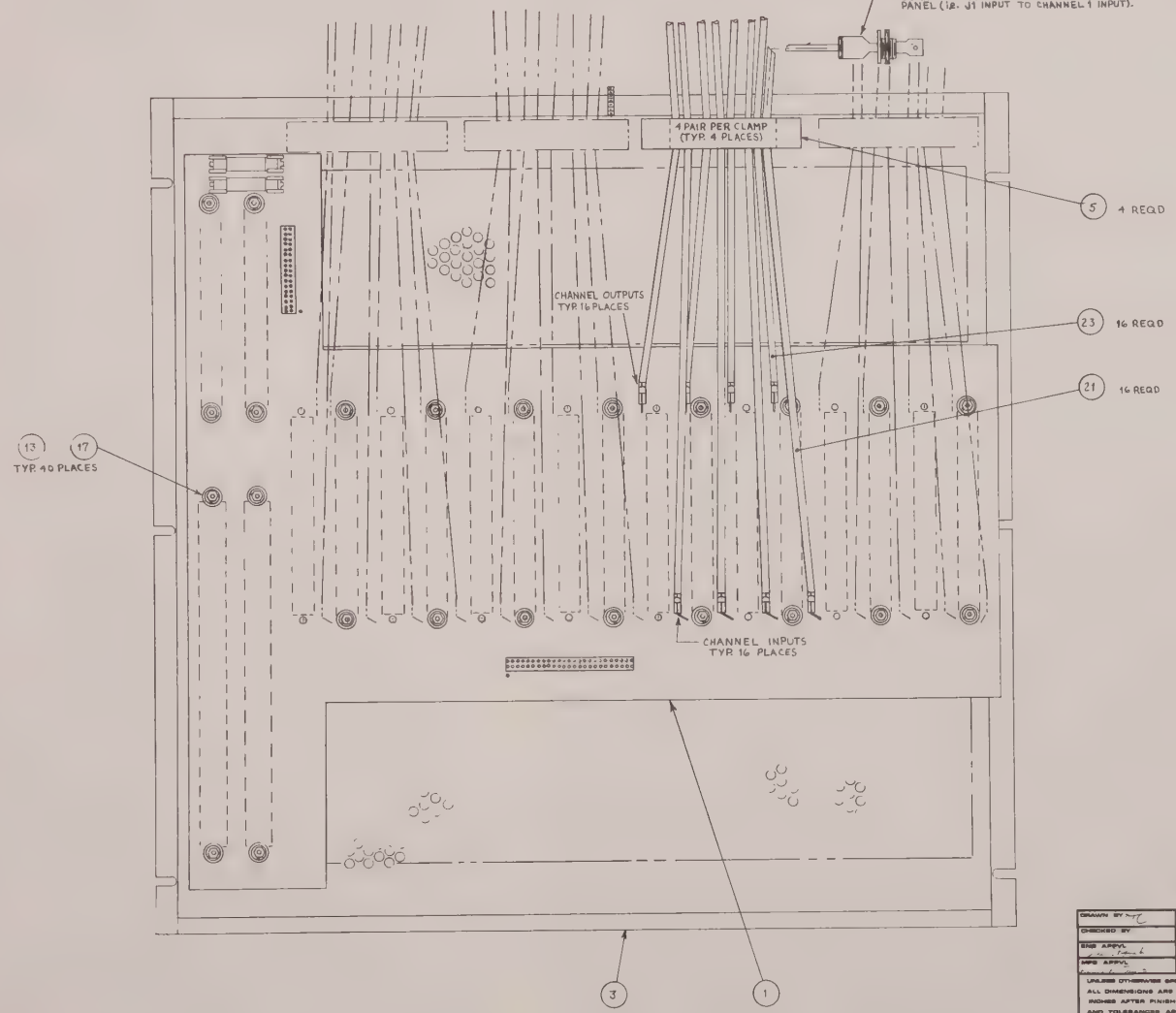
LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE			
B	1159	TL		


INSTALL BNC CONN. (TYP 32 PLACES) TO CORRESPONDING LOCATION ON REAR PANEL (i.e. J1 INPUT TO CHANNEL 1 INPUT).
4 PAIR PER CLAMP (TYP. 4 PLACES)
5 4 REQ'D
CHANNEL OUTPUTS TYP. 16 PLACES
23 16 REQ'D
21 16 REQ'D
13 17 TYP. 40 PLACES
CHANNEL INPUTS TYP. 16 PLACES
3
1

DRAWN BY	DATE 6/1/92	WAVETEK
CHECKED BY		
ENG APPVL		
MFG APPVL		

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER PLATING AND TOLERANCES ARE .XXX ± .005, .XX ± .01, X/x ± 1/64, ∠° ± 1°

TITLE: CARD CAGE ASSY (7116)

SIZE D | DRAWING NO. 02-002-3720 | REV B | SCALE FULL

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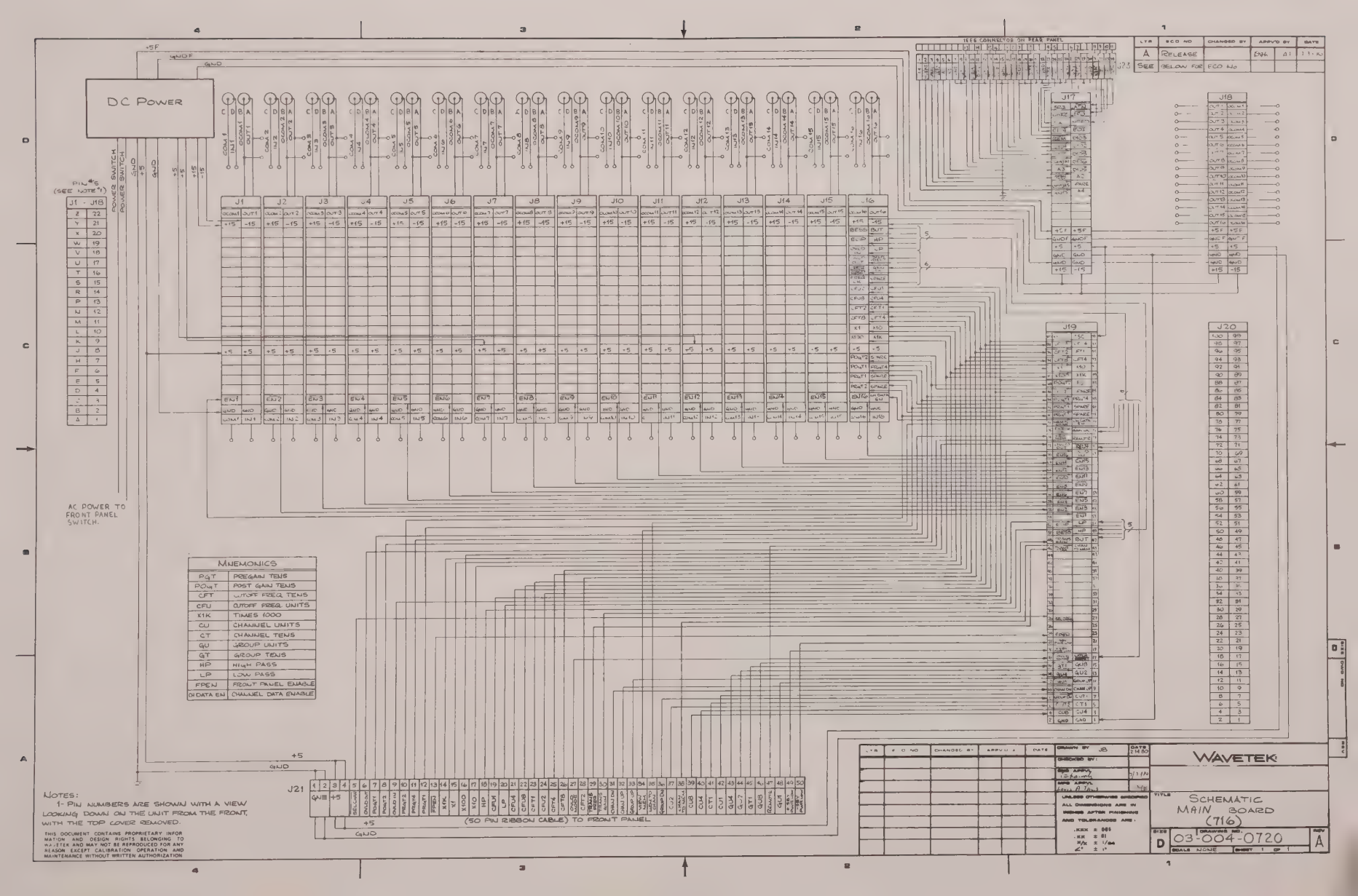
REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	MAINBOARD ASSY, 716			004 0720	1
NONE	SUPER KIT	2300-0716-01	WVTK	2300-0716-01	1
NONE	CARD CAGE, 716			307 0920	1
NONE	CLAMP CABLE FLAT	FCC163	RICH	362 1606	4
NONE	NUT HX ST ZN 4-40X1/4 AF			387 4080	40
NONE	WASHER SPLT LK SS #4			388 1042	40

WAVETEK PARTS LIST	TITLE: CARD CAGE ASSY 716	ASSEMBLY NO: 002 0720	REV: B
		PAGE 1	

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: PARTS LIST CARD CAGE
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1° XX ±.030		
	DO NOT SCALE DWG	MODEL NO: 716	DWG NO: 002.0720 REV: B
	SCALE	CAGE CODE: 23338	SHEET 1 OF 1


DC Power
+5F
GNDF
GND
IEEE CONNECTOR ON REAR PANEL
J1 - J16
J17
J18
J19
J20
J21
AC POWER TO FRONT PANEL SWITCH.
(50 PIN RIBBON CABLE) TO FRONT PANEL
MNEMONICS
PGT PREGAIN TENS
PGU PREGAIN UNITS
PGT POST GAIN TENS
PGU POST GAIN UNITS
CFT CUTOFF FREQ TENS
CFU CUTOFF FREQ UNITS
X1K TIMES 1000
CU CHANNEL UNITS
CT CHANNEL TENS
GU GROUP UNITS
GT GROUP TENS
HP HIGH PASS
LP LOW PASS
FPEN FRONT PANEL ENABLE
CH DATA EN CHANNEL DATA ENABLE
NOTES:
1- PIN NUMBERS ARE SHOWN WITH A VIEW LOOKING DOWN ON THE UNIT FROM THE FRONT, WITH THE TOP COVER REMOVED.
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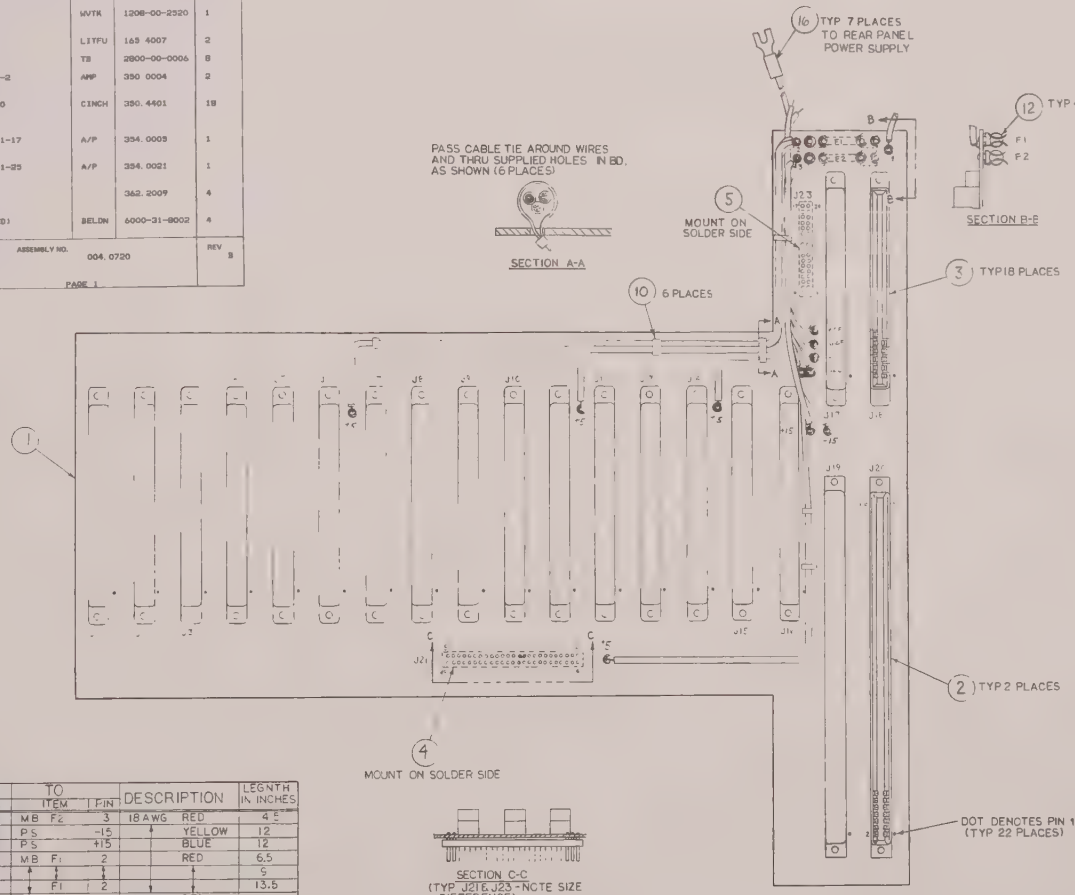
LTR ECO NO CHANGED BY APPVD BY DATE
A RELEASE DAK 8/11/83
SEE BELOW FOR ECO NO
DRAWN BY JB
CHECKED BY
QUAL APPVL
MFG APPVL
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE: .XXX ± .005 .XX ± .01 X/X ± 1/64 ∠° ± 1°
WAVETEK
TITLE SCHEMATIC MAIN BOARD (716)
SIZE D DRAWING NO. 03-004-0720 REV A
SCALE NONE SHEET 1 OF 1

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE		[illegible] LAT	
B	1159	TC	LDA AV	10/21/87

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	ASSY PC BD PREPPED 716-0720	716-2520	WVTK	1208-00-2520	1
F1 F2	FUSE, 3AG 10A SB 125V	314010	LITFU	165 4007	2
NONE	TY-WRAP	TY-523M	TB	2800-00-0006	8
J19 J20	CONN: PC .125 30POS DR ST FLMT	3-530662-2	AMP	350 0004	2
J1 J10 J11 J12 J13 J14 J15 J16 J17 J18 J2 J3 J4 J5 J6 J7 J8 J9	CONN: PC .156 22POS DR ST	30-448-10	CINCH	350.4401	18
J22	CONN, TERM 34 PIN DIL ST	929663-01-17	A/P	354.0009	1
J21	CONN: TERM 30PIN DIL ST	929663-01-25	A/P	354.0021	1
NONE	CLIP: FUSE MOUNTING, PC			362.2009	4
NONE	WIRE, 18GA	8501 (RED)	BELDN	6000-31-9002	4

WAVETEK PARTS LIST | TITLE: MAINBOARD ASSY, 716 | ASSEMBLY NO. 004.0720 | REV B | PAGE 1


16 TYP 7 PLACES TO REAR PANEL POWER SUPPLY
12 TYP 4 PLACES
F1
F2
SECTION B-B
B
PASS CABLE TIE AROUND WIRES AND THRU SUPPLIED HOLES IN BD. AS SHOWN (6 PLACES)
SECTION A-A
5 MOUNT ON SOLDER SIDE
10 6 PLACES
3 TYP 18 PLACES
A
A
1
2 TYP 2 PLACES
4 MOUNT ON SOLDER SIDE
SECTION C-C (TYP J2T&J23 - NOTE SIZE DIFFERENCE)
DOT DENOTES PIN 1 (TYP 22 PLACES)

REF	FROM ITEM	FROM PIN	TO ITEM	TO PIN	DESCRIPTION		LEGNTH IN INCHES
1	MB J21	+5	MB F2	3	18AWG	RED	4
2	↑	-5	PS	-15	↑	YELLOW	12
3		+15	PS	+15		BLUE	12
4	J15	+5	MB F1	2		RED	6.5
5	J12	↑	↑	↑		↑	5
6	J7	↓	F1	2		↓	13.5
7	J17	+5	MB F2	3	18AWG	RED	4
8	↑	GND	PS	-OUT	14AWG	BLACK	12
9		GND	↓	-OUT	14AWG	↓	15
10		GND		GNDF	18AWG	BLACK	10
11	↓ J17	+5F		+5F	18AWG	RED	10
12	MB F1-F2	1	PS	+5	14AWG	RED	12.25

MB = MAINBOARD
PS = POWER SUPPLY

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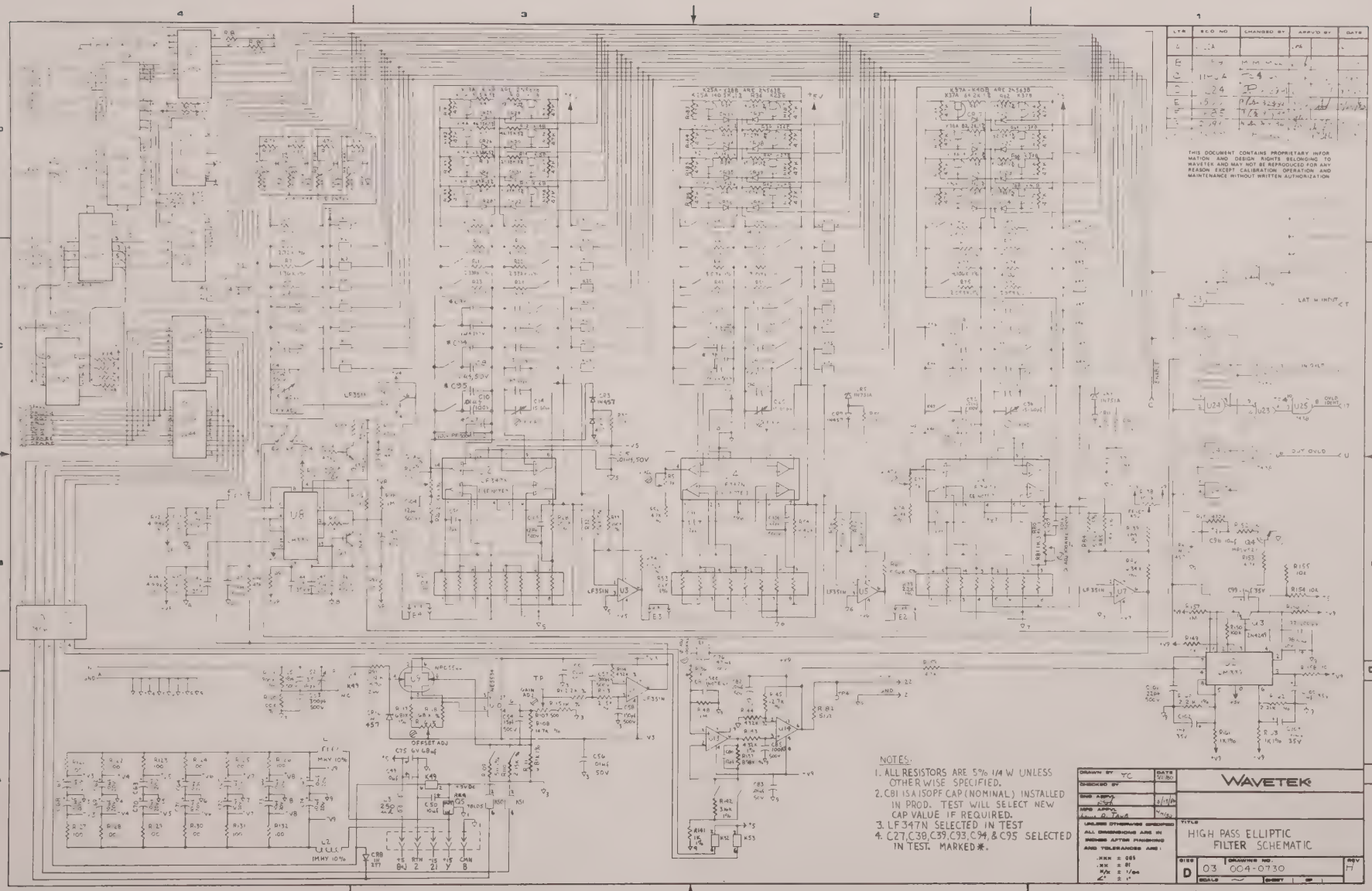
DRAWN BY TC DATE 5/8/80
CHECKING BY:
ENG APPV'L [illegible] 11/1/87
MFG APPV'L [illegible]
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCING ARE: .XXX ± .005 .XX ± .01 FR ± 1/64 ∠° ± 1°

WAVETEK

TITLE: ASSEMBLY MAINBOARD '716' COMPONENT SIDE

SIZE D | DRAWING NO. 02-004-0720 | REV B | SCALE 1:1



LTR	ECO NO	CHANGED BY	APPVD BY	DATE
L	-14		-14	
K	-13		-13	
J	-12		-12	
H	-11		-11	
G	-10		-10	
F	-09		-09	
E	-08		-08	

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NOTES:
1. ALL RESISTORS ARE 5% 1/4 W UNLESS OTHERWISE SPECIFIED.
2. CBI IS A ISOPF CAP (NOMINAL) INSTALLED IN PROD. TEST WILL SELECT NEW CAP VALUE IF REQUIRED.
3. LF347N SELECTED IN TEST
4. C27, C38, C39, C93, C94, & C95 SELECTED IN TEST. MARKED *.

DRAWN BY TC	DATE 5/1/80	WAVETEK
CHECKED BY		
ENG APPVL	5/1/80	
MFG APPVL		

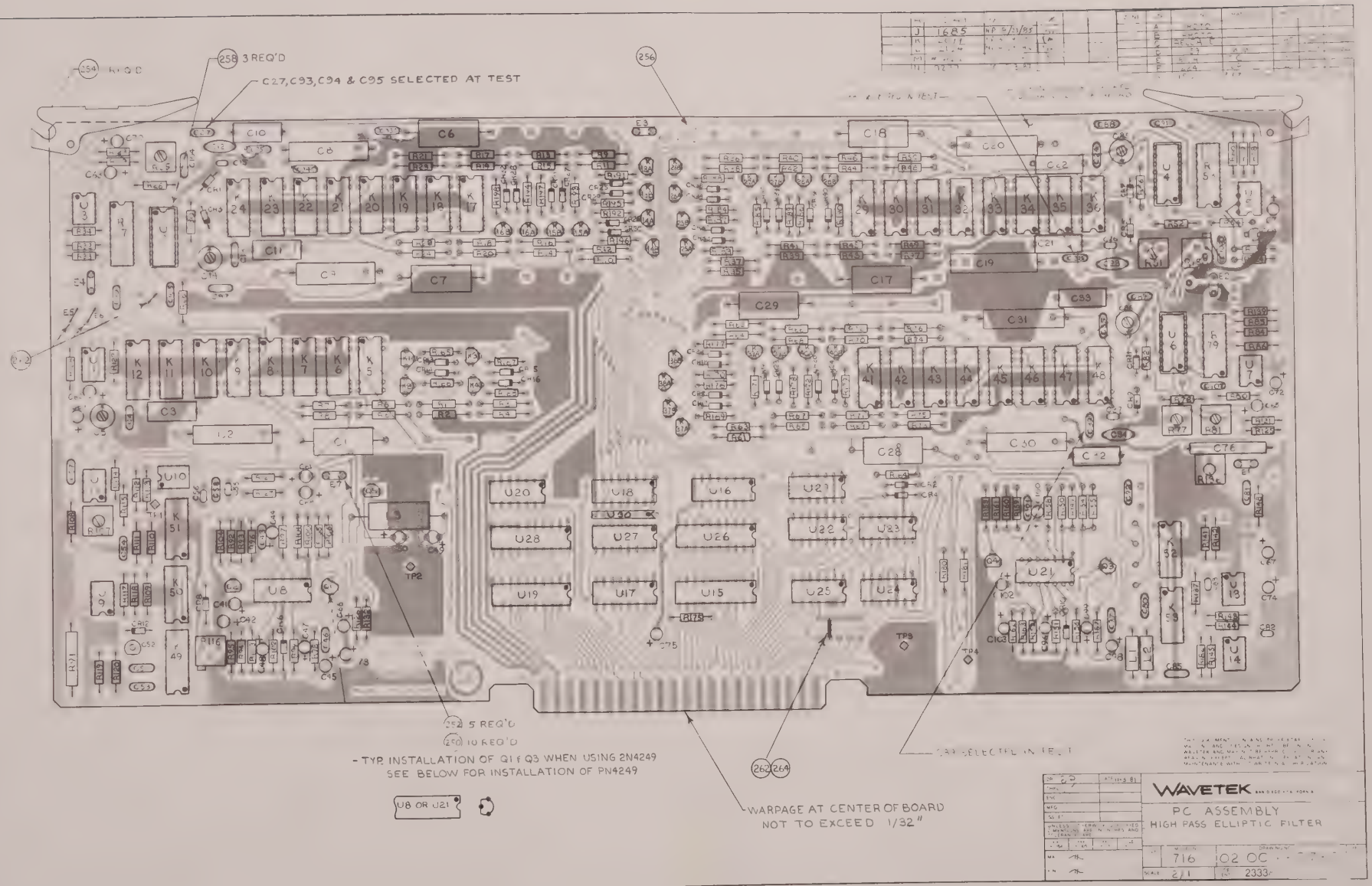
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER MACHINING AND TOLERANCES ARE: .XXX ± 005, .XX ± 01, X/X ± 1/64, ∠ ± 1°

TITLE: HIGH PASS ELLIPTIC FILTER SCHEMATIC

SIZE	DRAWING NO.	REV
D	03 004-0730	M

SCALE ~ SHEET 1

03-004-0730


254 4 REQ'D
258 3 REQ'D
C27, C93, C94 & C95 SELECTED AT TEST
256
252 5 REQ'D
250 10 REQ'D
- TYP. INSTALLATION OF Q1 & Q3 WHEN USING 2N4249
SEE BELOW FOR INSTALLATION OF PN4249
U8 OR U21
262 264
WARPAGE AT CENTER OF BOARD
NOT TO EXCEED 1/32"
WAVETEK
PC ASSEMBLY
HIGH PASS ELLIPTIC FILTER
716
102 OC
2333

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
C13 C26 C37 C55 C56 C62 C83	CAP,MOND, .01UF +80 -20% 50V	SR215E103ZAT	AVX	100.3103	7
C104 C105 C80 C90 C91 C92	CAP MICA FX VA DIP 12PF 5% 200 PPM/C 300V	CM05CD120J03	CDE	101.0120	6
C34	CAP MICA FX VAL DIP 13PF 5% 200 PPM/C 300V	CM05CD130J03	CDE	101.0130	1
C51	CAP MICA FX VAL DIP 18PF 5% 200 PPM/C 300V	CM05CD180J03	CDE	101.0180	1
C101 C106 C43 C87 C88 C89	CAP MICA FX VAL DIP 22PF 5% -20+100PPM/C 300V	CM05ED220J03	CDE	101.0220	6
C107	CAP MICA FX VAL DIP 30PF 5% -20+100PPM/C 300V	CM05ED300J03	CDE	101.0300	1
C85	CAP FX VAL,DP MICA 100PF 5% 0 TO +70PPM/C 500V	CM05FD101J03	CDE	101.1100	1
C58 C81	CAP FX VAL,DP MICA 150PF 5% 0 TO +70PPM/C 500V	CM05FD151J03	CDE	101.1150	2
C46 C97	CAP FX VAL,DP MICA 200PF 5% 0 TO +70PPM/C 500V	CM05FD201J03	CDE	101.1200	2
C53 C57	CAP FX VAL,DP MICA 300PF 5% 0 TO +70PPM/C 500V	CM05FD301J03	CDE	101.1300	2
C13 C24 C35 C4	CAP MICA FX VAL DIP 910PF 1% 0 TO+70PPM/C 100V	CD15FA911F03	CDE	101.1910	4
C12 C23 C34	CAP MICA FX VAL DIP 1000PF-	CM06FD102F03	CDE	101.2101	3
C10 C11 C21 C22 C3 C32 C33	CAP,POLYSTY, .01UF,-.5 +0%,50V	PSBPC0103E	AMRAD	104.3106	7
C2	CAP,POLYSTY, 0.1UF -.5+0% 50V	PSW0104E	AMRAD	104.4106	1
C19 20 C30 31 C8 9	CAP,POLYSTY, 0.1UF 50V SET	PSW0104F-MB	AMRAD	104.4107	3
C1 C17 C18 C28 C29 C6 C7	CAP,POLYCARB,1 0UF-.5 +0%,50V	MPABPC0105E	AMRAD	104 3103	7
C76	CAP,PLSTR, .47UF 5% 100V	A11B474J	BIGMO	105.4470	1
C52	CAP,VAR,CER, 3 9-18PF 250V	9373	JACO	108.0180	1
C14 C25 C36 C5	CAP,VAR,CER, 15-60PF	538-011-F	MILOV	108.0600	4

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0730 | ASSEMBLY NO 1208-00-2526 | REV A | PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
C100 C102 C103 C41 C42 C44 C47 C99	CAP,TANT, .10UF 20% 35V	T355A104M035AS	KEMET	109.4100	8
C45 C48 C49 C50 C61 C62 C63 C64 C65 C66 C67 C68 C69 C70 C71 C72 C73 C74 C96 C98	CAP,TANT, 10UF 20% 20V	T356B106M025AS	KEMET	109.6100	20
C75	CAP,TANT, 68UF 20% 6V	T368B686M006AS	KEMET	109.6680	1
R109	RES,MFLM 511 OHM 1% 1/10W T2	RN55C5110F	ENOX	110.5111	1
R8	RES, FX MFLM 681 OHM 1% 1/8W T0	RN55C6810F	UMCEM	110.6810	1
R115 R141 R161 R163 R93 R99	RES,MFLM 1.00K 1% 1/10W T2	RN55C1001F	UMCEM	111.1001	6
R23 R24	RES,MFLM 1.169K .5% 1/8W T0	CR125 100PPM	CTLRE	111.1168	2
R7	RES,MFLM 1.36K 1% 1/8W T0	NA	NA	111.1360	1
R49 R50	RES,MFLM 1.757K .1% 1/8W T0	HA55 100PPM	HYMEQ	111.1758	2
R112	RES,MFLM 2.00K 1% 1/10W T2	RN55C2001F	UMCEM	111.2001	1
R73 R76	RES,MFLM 2.053K .1% 1/8W T0	HA55 100PPM	HYMEQ	111 2059	2

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 3

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R19 R20	RES,MFLM 4 675K 5% 1/8W T0	HA55 100PPM	HYMEQ	111.4678	2
R92 R94	RES,MFLM 4.99K 1% 1/10W T2	RN55C4991F	UMCEM	111.4991	2
R5	RES,MFLM 5 45K 1% 1/8W T0	CR125	CTLRE	111 5450	1
R32 R34 R58 R60 R84	RES,MFLM 5.36K .5% 1/10W T2	RN55C5361D	ENOX	111.5361	5
R86	RES,MFLM 6.34K 1% 1/10W T2	RN55C6341F	UMCEM	111.6341	1
R111 R117 R118 R4	RES,MFLM 6.81K 1% 1/10W T2	RN55C6811F	UMCEM	111.6811	4
R45 R46	RES,MFLM 7 027K 1% 1/8W T0	HA55 100PPM	HYMEQ	111.7028	2
R71 R72	RES,MFLM 8.212K .1% 1/8W T0	HA55 100PPM	HYMEQ	111.8219	2
R137	RES,MFLM 8 98K .5% 1/10W T2	RN55C8981D	KAGAN	111.8981	1
R17 R18	RES,MFLM 9 351K .5% 1/8W T0	CR125 100PPM	CTLRE	111.9358	2
R15 R16	RES,MFLM 11 69K .5% 1/8W T0	CR125 100PPM	CTLRE	112.1168	2

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0730 | ASSEMBLY NO 1208-00-2526 | REV A | PAGE 5

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R110 R113	RES,MFLM 2.15K 1% 1/10W T2	RN55C2151F	UMCEM	111.2151	2
R160 R162	RES,MFLM 2.21K 1% 1/10W T2	RN55C2211F	UMCEM	111.2211	2
R21 R22	RES,MFLM 2.338K .5% 1/8W T0	HA55 100PPM	HYMEQ	111.2338	2
R91	RES,MFLM 2.40K 5% 2W 200PPM	FP42 2 4K 5% 2W 200PPM	CORNG	111.2403	1
R6	RES,MFLM 2.72K 1% 1/8W T0	CR125 100PPM	CTLRE	111 2720	1
R142	RES,MFLM 3.16K 1% 1/10W T2	RN55C3161F	UMCEM	111.3161	1
R80	RES,MFLM 3.40K 1% 1/10W T2	RN55C3401F	UMCEM	111 3401	1
R47 R48	RES,MFLM 3.513K .1% 1/8W T0	HA55 100PPM	HYMEQ	111.3518	2
R73 R74	RES,MFLM 4.106A .1% 1/8W T0	HA55 100PPM	HYMEQ	111.4109	2
R114 R143 R144	RES,MFLM 4.32K 1% 1/10W T2	RN55C4321F	UMCEM	111.4321	3
R54	RES,MFLM 4.42K 1% 1/10W T2	RN55C4421F	UMCEM	111.4421	1

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0730 | ASSEMBLY NO 1208-00-2526 | REV A | PAGE 4

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R145	RES,MFLM 12.7K 1% 1/10W T2	RN55C1272F	UMCEM	112.1271	1
R3	RES,MFLM 13.6K 1% 1/8W T0	CR125 100PPM	CTLRE	112.1360	1
R43 R44	RES,MFLM 14.03K .1% 1/8W T0	HA55 100PPM	HYMEQ	112.1408	2
R108 R52	RES,MFLM 14.7K 1% 1/10W T2	RN55C1472F	UMCEM	112.1471	2
R83	RES,MFLM 15 4K 1% 1/10W T2	CR125 50PPM	CTLRE	112 1541	1
R69 R70	RES,MFLM 16 42K 1% 1/8W T0	HA55 100PPM	HYMEQ	112 1649	2
R41 R42	RES,MFLM 17.57K .1% 1/8W T0	HA55 100PPM	HYMEQ	112.1758	4
R26 R28	RES,MFLM 20.3K 1% 1/8W T0	RN55C2032F	UMCEM	112.2030	2
R67 R68	RES,MFLM 20.53K .1% 1/8W T0	HA55 100PPM	HYMEQ	112.2058	2
R13 R14	RES,MFLM 23.36K .5% 1/8W T0	CR125 100PPM	CTLRE	112 2338	2
R2	RES,MFLM 27.2K 1% 1/8W T0	CR125 100PPM	CTLRE	112.2720	1

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0730 | ASSEMBLY NO 1208-00-2526 | REV A | PAGE 6

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: PARTS LIST HI-PASS BRICKWALL FILTER
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ±1° XX ± .030		
	DO NOT SCALE DWG		MODEL NO 716 · DWG NO 004.0730 · REV N
	SCALE	CODE IDENT 23338	SHEET 1 OF 3

NOTE UNLESS OTHERWISE SPECIFIED

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R39	RES MF FIX VALUE 0.5% 30PPM RN55 SIZE	RN55C3052D	MIL	112.3051	1
R39 R40	RES.MFLM 35 13K 1% 1/8W TO	HA55 100PPM	HYMEQ	112.3518	2
R65 R66	RES.MFLM 41 06K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 4108	2
R11 R12	RES.MFLM 46 75K 1% 1/8W TO	CR125 100PPM	CTLRE	112 4678	2
R1	RES.MFLM 54 9K 1% 1/8W TO	CR125 100PPM	CTLRE	112 5450	1
R78	RES MFLM 60 4K 1% 1/10W T2	RN55C6042F	UNCEM	112 6041	1
R37 R38	RES.MFLM 70 27K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 7028	2
R63 R64	RES.MFLM 82 12K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 8218	2
R10 R9	RES.MFLM 93 31K 1% 1/8W TO	CR125 100PPM	CTLRE	112 9338	2
R120	RES.MFLM 100K 1% 1/10W T2	RN55C1003F	UNCEM	113.1001	1
R35 R36	RES.MFLM 140.3K 1% 1/8W TO	HA55 100PPM	HYMEQ	113.1408	2

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 7

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R101 R150	RES.CFLM 100K OHM 5% 1/4W			116 4101	2
R102 R151	RES.CFLM 470K OHM 5% 1/4W	R25JE470K	ROHM	116.4471	2
R139 R148 R157 R98	RES.CFLM 1 OM OHM 5% 1/4W			116 5101	4
R107 R25	RES. VAR CMT 500 OHM 3/8SQ FM	72PR500	BECK	118 1503	2
R136 R51 R81	RES. VAR CMT 1.0K 3/8SQ FM	72PR1K	BECK	118 2102	3
R116	RES. VAR CMT 1 0K 3/8SQ FMHY 19T	68PR1K	BECK	118.2103	1
R77	RES. VAR CMT 5 0K 3/8SQ FM	72PR5K	BECK	118 2502	1
R130	RES. VAR CMT 100K 3/8SW FMHY 18T	68PR100K	BECK	118 4104	1
Q5	Q P V REG 5V (78L05)	LM78L05ACZ	NSC	120 0053	1
U1 U11 U13 U3 U5 U7	U LIN BIFET OP-AMP DIL LF351	LF351N	NSL	120 1017	6
U10 U14	U LIN OP-AMP DIL (NE5534A)	SA5534AN	SIG	120 1018	2

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 9

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
U22	U QUAD 2IN NOR GATE	SN74L902N 3	TI	125 7402	1
U30	U PULL UP NET 1K 2% 7 SIP	4308R-101-102	BOURN	128 2102	1
RS3 R79	RES.NETWORK. 2 2K OHM 1% 8B	4116R-001-2 2K	BOURN	128 2203	2
R27	RES.NETWORK. 10K OHM 1% 8B	698-3-R10K-F	BECK	128 3103	1
CR5 CR9	SL ZR 5 1V 5% 400MW (1N731A)			131 9510	2
CR8	GER 120PIV 100MA (1N277)			132 0277	1
CR1 CR10 CR11 CR12 CR13 CR14 CR15 CR16 CR17 CR18 CR19 CR2 CR20 CR21 CR22 CR23 CR24 CR25 CR26 CR27 CR28 CR29 CR3 CR30 CR31 CR32 CR33 CR34 CR35 CR36 CR37 CR38 CR39 CR4 CR40 CR6 CR7	SL LW LK 70PIV 200MW (1N457)			132 0457	37
Q2 Q4	G SIL NPN (MPS6521)	MPS6521	MOT	135 6521	2
Q1 Q3	G SIL PNP (2N4249)	2N4249	FAIR	136 4249	2
U9	G DL MATCH FET (NPD-5566)	NPD-5566	NSC	138 5566	1

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 11

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R61 R62	RES.MFLM 164 2K 1% 1/8W TO	HA55 100PPM	HYMEQ	113 1648	2
R33	RES.MFLM 200K 1% 1/10W T2	RN55C2003F	UNCEM	113 2001	1
R119	RES.MFLM 900K 1% 1/10W T2	CR250	CTLRE	113.9009	1
R156 R158 R180 R181 R97 R99	RES.CFLM 10 OHM 5% 1/4W			116.0101	6
R182	RES.CFLM 51 OHM 5% 1/4W			116.0511	1
R103 R121 R122 R123 R124 R125 R126 R127 R128 R129 R130 R131 R132 R132	RES.CFLM 100 OHM 5% 1/4W	CF1/4-100OHM.5%	STKPL	116 1101	14
R173	RES.CFLM. 1.0K OHM 5% 1/4W	CF-071K-5%	DALE	116.2101	1
R104 R153 R159 R96	RES.CFLM 4.7K OHM 5% 1/4W	R25JE4.7K	ROHM	116.2471	4
R100 R105 R106 R149 R154 R155 R164 R30 R56 R82	RES.CFLM 10K OHM 5% 1/4W			116.3101	10
R163 R166 R167 R168 R169 R170 R171 R172 R176 R177 R178 R179 R182 R184 R185 R186 R187 R188 R189 R190 R191 R192 R193 R194 R195 R196 R197 R198	RES.CFLM 47K OHM 5% 1/4W			116 3471	28

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 8

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
U29	U. GD LIN OP-AMP (LM324N)	LM324N	NSC	120 2324	1
U21 U8	U QUAD ANAL VOLT COMP (LM339)	LM339N	MOT	120 3339	2
U16 U18	U. HEX MOS-LED DRIVER (75494)	DM75494N	NSC	120 4494	2
NONE	ASSY, PC BD PREPPED 716-0730	716-2527	WVTK	1208-00-2527	1
U20	U: HEX INVERT DRIVER O/C	SN7406N-3	TI	122 7406	1
U25	U GD 2 IN NAND BUFFER O/C	N7438N-8	SIG	122.7438	1
U27	U: HX 3-ST BUS BUFF (74LS367)	DM74LS367N/A+	NSC	125 0131	1
U17	U: 4 BT LATCH (74LS375)	SN74LS375N-3	TI	125.0141	1
U15 U19	U 8 BT LATCH 3-ST (74LS373)	N74LS373N-8	SIG	125.0147	2
U26 U28	U OCT BUF 3-ST (74LS244)	SN74LS244N-8	SIG	125.0153	2
U23 U24	U. QUAD 2 IN NAND GATE	SN74LS00N-3	TI	125.7400	2

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 10

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
K13A K13B K14A K14B K15A K15B K16A K16B K1A K25A K25B K26A K26B K27A K27B K28A K28B K2A K37A K37B K38A K38B K39A K39B K3A K40A K40B K4A	G FET N-CHAN JCT	2N5638	NSC	138 5638	28
L1 L2	L FXD 1 MHY +/-10% SMLD	1641-105	DELVN	150 2100	2
K10 K11 K12 K5 K50 K51 K52 K53 K6 K7 K8 K9	RELAY REED DIP 1A W/DIODE 5V	1303-8-1	WABSH	175 1505	12
K49	RELAY REED DIP 1C W/DIODE 5V	815-244-114	WABSH	175 1506	1
K17 K18 K19 K20 K21 K22 K23 K24 K29 K30 K31 K32 K33 K34 K35 K36 K41 K42 K43 K44 K45 K46 K47 K48	RELAY REED DIP 2A W/DIODE 5V	1303-7-1	WABSH	175 1507	24
NONE	SOCKET IC 14PIN DIP ST	ICN-1143-83-G	ROBMU	353 1403	3
TP1 TP2 TP3 TP4	CONN TERM PIN .025 WW (2END)	M239-025-5000	A/S	354 0007	4

WAVETEK PARTS LIST | TITLE: ABSY, PRE WAVE LOAD 716-0730 | ASSEMBLY NO. 1208-00-2526 | REV A | PAGE 12

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE: PARTS LIST HI-PASS BRICKWALL FILTER
	RELEASE APPROV		
FINISH: WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED: XXX ±.010 ANGLES ±1° XX ±.020		
	DO NOT SCALE DWG		
	SCALE		MODEL NO: 716 / DWG NO: 004.0730 / REV: N
	CODE IDENT: 23338		SHEET 2 OF 3

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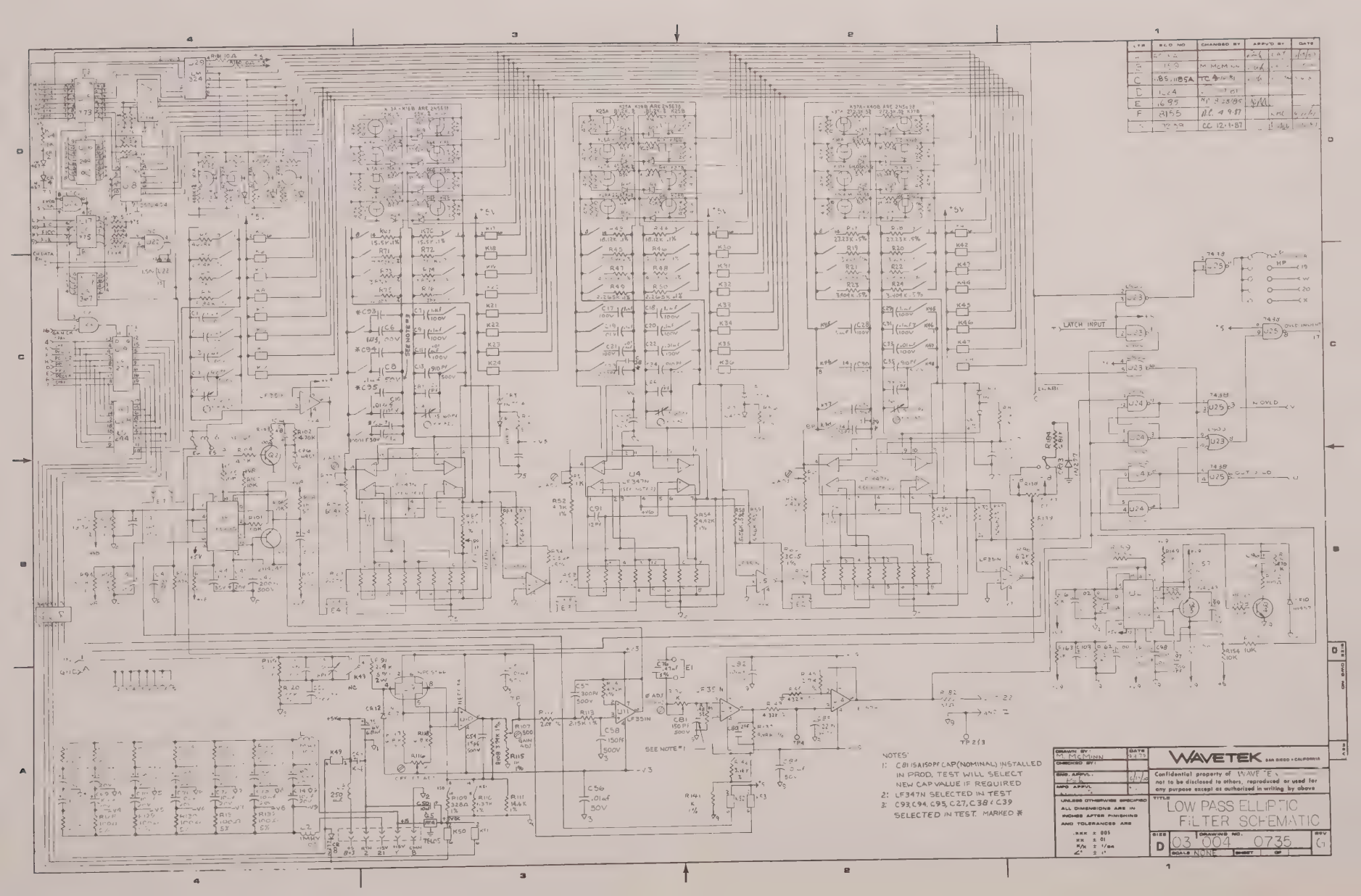
REV	ECN	BY	DATE	APP

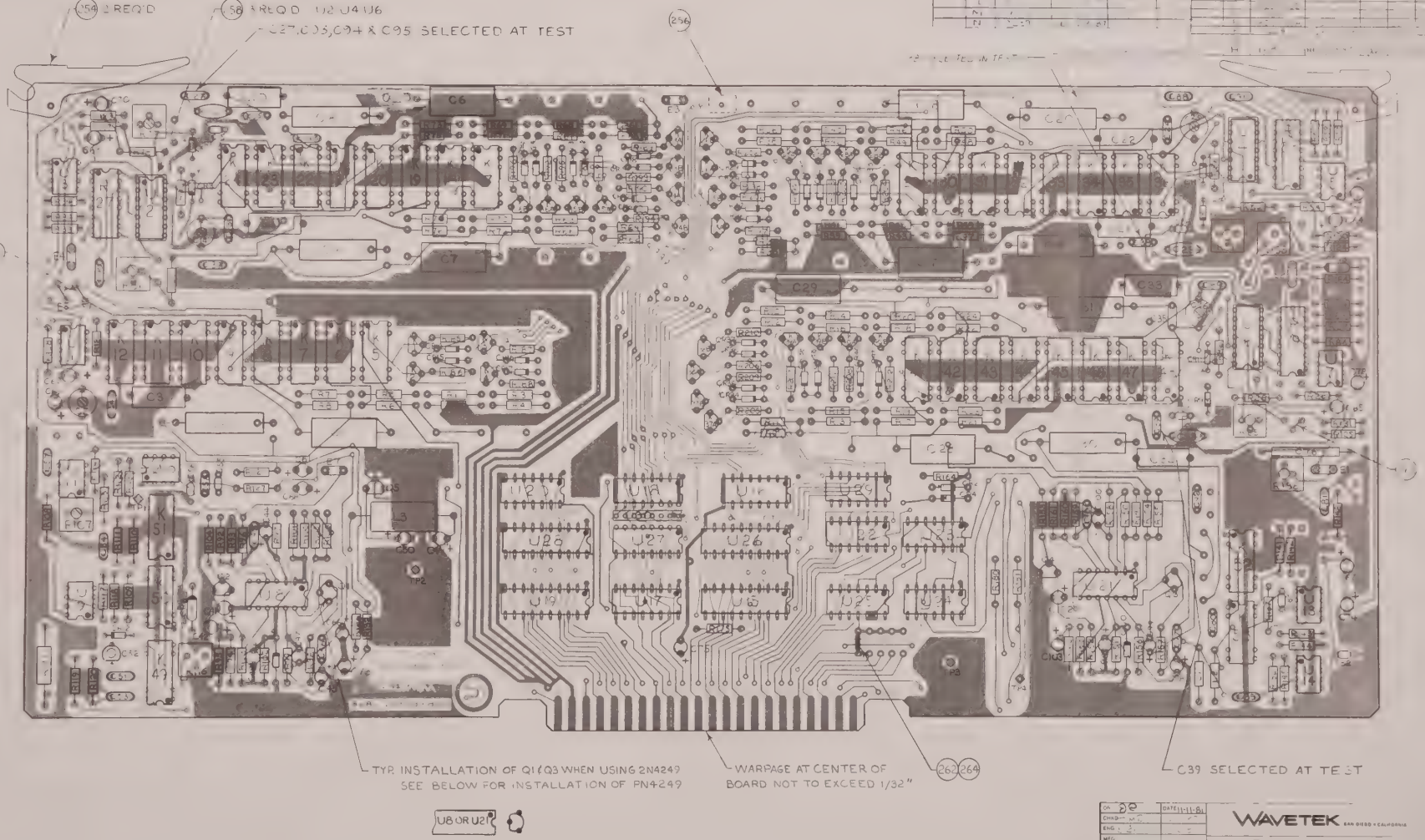
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
U2 U4 U6	SPK U GD LIN BIFET OP-AMP (SEL347			120 2007	3
NONE	ASSY, PRE WAVE LOAD 716-0730	716-2526	WVTK	1208-00-2526	1
L3	L: FXD 250 UHY HI-CURR	6310-9	CADBU	150.1231	1
NONE	CONN, PLUG SHORTING (LOW PROF)	4612872-01-03-10	CTC	332 0202	5
NONE	SOCKET JMPR (USE W/332 0202)	4503327-01-0300	CTC	333 0104	10
NONE	EJECTOR PC, 716	NE3001-W	ELESP	364 0403	2
NONE	SPACER NYL SNAP-BTN (MB1-136)	MB-1-136	P&MC	376 2109	1
262	WIRE BUSS TINNED 22GA	9022	WEICO	378 0601	2 4
264	SLVNG PLASTIC FBROLB 22AWG			378 3221	2 3

WAVETEK PARTS LIST	TITLE: TOP OPT 716-002, FILTER CARD HI-PASS BRICKWALL	ASSEMBLY NO: 004 0730	REV: N
		PAGE 1	

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: PARTS LIST HI-PASS BRICKWALL FILTER
	RELEASE APPROV		
FINISH: WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ±1° XX ± .030		MODEL NO: 716 DWG NO: 004 0730 REV: N
	DO NOT SCALE DWG		
	SCALE		TRON PART NO: 23338 SHEET 3 OF 3


LTR
ECO NO
CHANGED BY
APPV'D BY
DATE
A
B
C
D
E
F
M. McMINN
CC 12-1-87
NOTES:
1: C81 IS A 150PF CAP (NOMINAL) INSTALLED IN PROD. TEST WILL SELECT NEW CAP VALUE IF REQUIRED
2: LF347N SELECTED IN TEST
3: C93, C94, C95, C27, C38 & C39 SELECTED IN TEST. MARKED *
DRAWN BY
M. McMINN
DATE
3-4-73
CHECKED BY
ENG. APPVL.
MFG APPVL.
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
.XXX ± .005
.XX ± .01
FRX ± 1/64
∠° ± 1°
WAVETEK SAN DIEGO, CALIFORNIA
Confidential property of WAVETEK not to be disclosed to others, reproduced or used for any purpose except as authorized in writing by above
TITLE
LOW PASS ELLIPTIC FILTER SCHEMATIC
SIZE
D
DRAWING NO.
03-004-0735
REV
G1
SCALE NONE
SHEET
OF



DR	DE	DATE 11-11-81
CHKD		
ENG		
MFG		
QA		

WAVETEK SAN DIEGO, CALIFORNIA

P.C. ASSEMBLY
LOW PASS ELLIPTC FILTER

SIZE	MODEL NO	DRAWING NO	REV
D	716	02-004-0735	
SCALE 2:1		CODE IDENT 23358	

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
C13 C26 C37 C55 C56 C82 C83	CAP, MOND. .01UF +80 -20% 50V	SR215E103ZAT	AVX	100 3105	7
C80 C90 C91 C92	CAP MICA FX VA DIP 12PF 5% 200 PPM/C 500V	CM05CD120J03	CDE	101.0120	4
C54	CAP MICA FX VAL DIP 13PF 5% 200 PPM/C 500V	CM05CD130J03	CDE	101 0130	1
C51	CAP MICA FX VAL DIP 18PF 5% 200 PPM/C 500V	CM05CD180J03	CDE	101 0180	1
C101 C43 C85 C87 C88 C89	CAP MICA FX VAL DIP 22PF 5% -20+100PPM/C 500V	CM05ED220J03	CDE	101 0220	6
C58 C81	CAP FX VAL. DP MICA 150PF 5% 0 TO +70PPM/C 500V	CM05FD151J03	CDE	101 1150	2
C46 C97	CAP FX VAL. DP MICA 200PF 5% 0 TO +70PPM/C 500V	CM05FD201J03	CDE	101 1200	2
C53 C57	CAP FX VAL. DP MICA 300PF 5% 0 TO +70PPM/C 500V	CM05FD301J03	CDE	101 1300	2
C13 C24 C35 C4	CAP MICA FX VAL DIP 910PF 1% 0 TO+70PPM/C 100V	CD15FA911F03	CDE	101.1910	4

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO. 1208-00-2528	REV A

PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
R109	RES, MFLM 328 OHM 1/10W T2	RN55C3280D	ENOX	110 3281	1
R115 R141 R161 R163 R93 R95	RES, MFLM 1 00K 1% 1/10W T2	RN55C1001F	UMCEM	111 1001	6
R110	RES, MFLM 1 37K 1% 1/8W TO	RN55C1371F	UMCEM	111 1370	1
R75 R76	RES, MFLM 1 938K 1% 1/8W TO	HA55 100PPM	HYMEQ	111 1939	2
R112	RES, MFLM 2.00K 1% 1/10W T2	RN55C2001F	UMCEM	111.2001	1
R113	RES, MFLM 2 15K 1% 1/10W T2	RN55C2151F	UMCEM	111 2151	1
R160 R162	RES, MFLM 2 21K 1% 1/10W T2	RN55C2211F	UMCEM	111 2211	2
R49 R50	RES, MFLM 2 265K 1% 1/8W TO	HA55 100PPM	HYMEQ	111 2269	2
R91	RES, MFLM 2, 40K 5% 2W 200PPM	FP42 2 4K 5% 2W 200PPM	CORNO	111.2403	1
R142	RES, MFLM 3. 16K 1% 1/10W T2	RN55C3161F	UMCEM	111 3161	1
R80	RES, MFLM 3. 40K 1% 1/10W T2	RN55C3401F	UMCEM	111 3401	1

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO. 1208-00-2528	REV A

PAGE 3

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
R137	RES, MFLM 8 98K 1/10W T2	RN55C8981D	KAGAN	111 8981	1
R45 R46	RES, MFLM 9 059K 1/8W TO	HA55 100PPM	HYMEQ	111 9059	2
R7	RES, MFLM 11 7K 1/8W TO	CR125 100PPM	CTLRE	112 1170	1
R143	RES, MFLM 12 7K 1/10W T2	RN55C1272F	UMCEM	112 1271	1
R19 R20	RES, MFLM 13 62K 1/8W TO	CR125 100PPM	CTLRE	112 1368	2
R92 R94	RES, MFLM 13 7K 1/10W T2	RN55C1372F	ENOX	112 1371	2
R111	RES, MFLM 14 6K 1/8W TO	CR125 100PPM	CTLRE	112 1460	1
R52	RES, MFLM 14 7K 1/10W T2	RN55C1472F	UMCEM	112 1471	1
R84	RES, MFLM 15 4K 1/10W T2	CR125 50PPM	CTLRE	112 1541	1
R49 R70	RES, MFLM 15 50K 1/8W TO	HA55 100PPM	HYMEQ	112 1559	2
R86	RES, MFLM 16 2K 1/8W TO	RN55C1622F	UMCEM	112 1620	1

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO. 1208-00-2528	REV A

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
C12 C23 C34	CAP MICA FX VAL DIP 1000PF	CM06FD102F03	CDE	101 2101	3
C10 C11 C21 C22 C3 C32 C33	CAP, POLYSTY, .01UF, -0% 50V	PS8PC0103E	AMRAD	104 3106	7
C2	CAP, POLYSTY, 0.1UF -5+0% 50V	PSW0104E	AMRAD	104.4106	1
C19 20 C30 31 C8 9	CAP, POLYSTY, 0.1UF 50V SET	PSW0104F-NS	AMRAD	104.4107	3
C1 C17 C18 C28 C29 C6 C7	CAP, POLYCARB, 1.0UF-.5% 50V	MPA8PC0105E	AMRAD	104.5103	7
C76	CAP, PLSTR, .47UF 5% 100V	A118474J	BISHO	105 4470	1
C52	CAP, VAR, CER, 3.5-18PF 250V	9373	JACO	108.0180	1
C14 C25 C36 C3	CAP, VAR, CER, 15-60PF	538-011-F	MILQV	108.0600	4
C100 C102 C103 C41 C42 C44 C47 C99	CAP, TANT, .10UF 20% 35V	T355A104M035AS	KEMET	109.4100	8
C45 C48 C49 C50 C61 C62 C63 C64 C65 C66 C67 C68 C69 C70 C71 C72 C73 C74 C96 C98	CAP, TANT, 10UF 20% 20V	T368B106M025AS	KEMET	109 6100	20
C75	CAP, TANT, 68UF 20% 6V	T368B686M006AS	KEMET	109.6680	1

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO 1208-00-2528	REV A

PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R23 R24	RES, MFLM 3. 404K .5% 1/8W TO	CR125 100PPM	CTLRE	111.3408	2
R108	RES, MFLM 3. 74K 1% 1/10W T2	RN55C3741F	ARROW	111.3741	1
R73 R74	RES, MFLM 3. 876K .1% 1/8W TO	HA55 100PPM	HYMEQ	111.3879	2
R114 R143 R144	RES, MFLM 4. 32K 1% 1/10W T2	RN55C4321F	UMCEM	111.4321	3
R26 R28 R54	RES, MFLM 4. 42K 1% 1/10W T2	RN55C4421F	UMCEM	111.4421	3
R47 R48	RES, MFLM 4. 530K .1% 1/8W TO	HA55 100PPM	HYMEQ	111 4539	2
R33 R34 R58 R59 R85	RES, MFLM 5. 56K .5% 1/10W T2	RN55C5561D	ENOX	111. 5561	5
R8	RES, MFLM 5. 84K 1% 1/8W TO	CR125	CTLRE	111 5840	1
R21 R22	RES, MFLM 6. 808K .5% 1/8W TO	CR125	CTLRE	111. 6808	2
R117 R118 R184	RES, MFLM 6. 81K 1% 1/10W T2	RN55C6811F	UMCEM	111. 6811	3
R71 R72	RES, MFLM 7 732K .1% 1/8W TO	HA55 100PPM	HYMEQ	111.7739	2

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO 1208-00-2528	REV A

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART NO	MFGR	WAVETEK NO	QTY/PT
R43 R44	RES, MFLM 18 12K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 1819	2
R67 R68	RES, MFLM 19 38K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 1939	2
R41 R42	RES, MFLM 22 69K .1% 1/8W TO	HA55 100PPM	HYMEQ	112 2269	2
R6	RES, MFLM 23.4K 1% 1/8W TO	RN55C2342F	ENOX	112.2340	1
R17 R18	RES, MFLM 27.23K 5% 1/8W TO	CR125 100PPM	CTLRE	112 2728	2
R60	RES MF FIX VALUE 0.5% 50PPM RN55 SIZE	RN55C3052D	MIL	112.3051	1
R15 R16	RES, MFLM 34.04K 5% 1/8W TO	CR125 100PPM	CTLRE	112.3408	2
R65 R66	RES, MFLM 38.76K 1% 1/8W TO	HA55 100PPM	HYMEQ	112 3879	2
R39 R40	RES, MFLM 45.30K .1% 1/8W TO	HA55 100PPM	HYMEQ	112.4539	2
R5	RES, MFLM 46 8K 1% 1/8W TO	CR125 100PPM	CTLRE	112.4680	1
R4	RES, MFLM 38.4K 1% 1/8W TO	CR125 100PPM	CTLRE	112.3840	1

WAVETEK PARTS LIST	TITLE: ASSY, PRE WAVE LOAD 716-0735	ASSEMBLY NO 1208-00-2528	REV A

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NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: PARTS LIST LOW-PASS BRICKWALL FILTER
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1 XX ±.020		
	DO NOT SCALE DWG		MODEL NO 716 DWG NO 004.0735 REV N
	SCALE		CODE IDENT 23338 SHEET 1 OF 3

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R78	RES METB 60.4K 1% 1/10W T2	RN55C6042F	UMCEM	112 6041	1
R13 R14	RES.MFLM 68.0K 1% 1/8W TO	CR125 100PPM	CTLRE	112 6808	2
R63 R64	RES.MFLM 77.52K 1% 1/8W TO	HA55 100PPM	HYMEG	112 7759	2
R37 R39	RES.MFLM 90.59K 1% 1/8W TO	HA55 100PPM	HYMEG	112 9059	2
R120	RES.MFLM 100K 1% 1/10W T2	RN55C1003F	UMCEM	113 1001	1
R3	RES.MFLM 117K 1% 1/8W TO	CR125 100PPM	CTLRE	113 1170	1
R11 R12	RES.MFLM 136.2K 1% 1/8W TO	CR125 100PPM	CTLRE	113 1368	2
R61 R62	RES.MFLM 155.0K 1% 1/8W TO	HA55 100PPM	HYMEG	113 1559	2
R35 R36	RES.MFLM 181.2K 1% 1/8W TO	HA55 100PPM	HYMEG	113 1819	2
R32	RES.MFLM 200K 1% 1/10W T2	RN55C2003F	UMCEM	113 2001	1
R2	RES.MFLM 234K 1% 1/8W TO	CR125 100PPM	CTLRE	113 2340	1

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 7

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R10 R9	RES.MFLM 272.3K 1% 1/8W TO	HA55 100PPM	HYMEG	113 2728	2
R1	RES.MFLM 4.68K 1% 1/8W TO	CR125 100PPM	CTLRE	113 4680	1
R119	RES.MFLM 900K 1% 1/10W T2	CR250	CTLRE	113 9009	1
R136 R138 R180 R181 R97 R99	RES.CFLM 10 OHM 5% 1/4W			116 0101	6
R182	RES.CFLM 51 OHM 5% 1/4W			116 0511	1
R103 R121 R125 R127 R131 R122 R123 R124 R126 R128 R129 R130 R132 R152	RES.CFLM 100 OHM 5% 1/4W	CF1/4-100OHM-5%	STKPL	116 1101	14
R175	RES.CFLM. 1.0K OHM 5% 1/4W	CF-071K-5%	DALE	116 2101	1
R104 R153 R159 R96	RES.CFLM 4.7K OHM 5% 1/4W	R25JE4 7K	ROHM	116 2471	4
R100 R105 R106 R149 R154 R155 R164 R30 R56 R82	RES.CFLM 10K OHM 5% 1/4W			116 3101	10
R185 R186 R187 R188 R189 R190 R191 R192 R193 R194 R195 R196 R197 R198 R199 R200 R201 R202 R203 R204 R205 R206 R207 R208 R209 R210 R211 R212	RES.CFLM 47K OHM 5% 1/4W			116 3471	20

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 8

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R101 R150	RES.CFLM 100K OHM 5% 1/4W			116 4101	2
R102 R151	RES.CFLM 470K OHM 5% 1/4W	R25JE470K	ROHM	116 4471	2
R139 R148 R157 R98	RES.CFLM 1.0M OHM 5% 1/4W			116 5101	4
R107 R25	RES. VAR CMT 300 OHM 3/8SQ FM	[illegible]	BECK	118 1503	2
R136 R31 R81	RES. VAR CMT 1.0K 3/8SQ FM	72PR1K	BECK	118 2102	3
R116	RES. VAR CMT 1.0K 3/8SQ FMHY 18T	68PR1K	BECK	118 2103	1
R77	RES. VAR CMT 5.0K 3/8SQ FM	72PR5K	BECK	118 2502	1
R138	RES. VAR CMT 100K 3/8SW FMHY 18T	[illegible]	BECK	118 4104	1
Q5	Q P.V. REG 5V (78L05)	LM78L05ACZ	NSC	120 0053	1
U1 U11 U13 U3 U5 U7	U LIN BIFET OP-AMP DIL LF351	LF351N	NSC	120 1017	6

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 9

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
U10 U14	U LIN OP-AMP DIL (NE5534A)	SA5534AN	SIG	120 1018	2
U29	U QD LIN OP-AMP (LM324N)	LM324N	NSC	120 2324	1
U21 U8	U QUAD ANAL VOLT COMP (LM339)	LM339N	MOT	120 3339	2
U16 U18	U HEX MOS-LED DRIVER (75494)	DM75494N	NSC	120 4494	2
[illegible]	ASSY. PC BD PREPPED 716-0735	716-2529	WVTK	1208-00-2529	1
U20	U HEX INVERT DRIVER O/C	SN7406N-3	TI	122 7406	1
U25	U QD 2 IN NAND BUFFER O/C	N7406N-8	SIG	122 7438	1
U27	U HX 3-ST BUS BUFF (74LS367)	DM74LS367N/A+	NSC	125 0131	1
U17	U 4 BT LATCH (74LS375)	SN74LS375N 3	TI	125 0141	1
U15 U19	U 8 BT LATCH 3-ST (74LS373)	N74LS373N-8	SIG	125 0147	2
U26 U28	U OCT BUF 3-ST (74LS244)	SN74LS244N-8	SIG	125 0153	2

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 10

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
U23 U24	U QUAD 2 IN NAND GATE	SN74LS00N-3	TI	125 7400	2
U22	U QUAD 2IN NOR GATE	SN74LS02N-3	TI	125 7402	1
U30	U PULL UP NET 1K 2% X7 SIP	4308R-101-102	BOURN	128 2105	1
R27 R53 R79	RES.NETWORK. 2.2K OHM 1% X8	4116R-001-2.2K	BOURN	128 2223	3
CR3 CR5 CR9	BL ZR 5.1V 5% 400MW (1N751A)			131 9510	3
CR13 CR8	GER 120PIV 100MA (1N277)			132 0277	2
CR1 CR11 CR12 CR7 CR10 CR6 CR14 CR15 CR16 CR17 CR18 CR19 CR2 CR20 CR21 CR22 CR23 CR24 CR25 CR26 CR27 CR28 CR29 CR30 CR31 CR32 CR33 CR34 CR35 CR36 CR37 CR38 CR39 CR4 CR40 CR41	SL LW LK 70PIV 200MW (1N457)			132 0457	36
Q2 Q4	Q SIL NPN (MPS6521)	MPS6521	MOT	135 6521	2
Q1 Q3	Q SIL PNP (2N4249)	2N4249	FAIR	136 4249	2
U9	Q DL MATCH FET (NPD-5566)	NPD-5566	NSC	138 5566	1
K1 K13A K13B K14A K14B K15A	Q FET N-CHAN JCT	2N5638	NSC	138 5638	20

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 11

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
K15B K16A K16B K2 K25A K25B K26A K26B K27A K27B K28A K28B K3 K37A K37B K38A K38B K39A K39B K4 K40A K40B					
L1 L2	L FXD 1 MHY +/-10% SHLD	1641-105	DELVN	150 2100	2
K10 K11 K12 K5 K50 K51 K52 K53 K6 K7 K8 K9	RELAY REED DIP 1A W/DIODE 5V	1303-8-1	WABSH	175 1308	12
K49	RELAY REED DIP 1C W/DIODE 5V	815-244-114	WABSH	175 1506	1
K17 K18 K19 K20 K21 K22 K23 K24 K29 K30 K31 K32 K33 K34 K35 K36 K41 K42 K43 K44 K45 K46 K47 K48	RELAY REED DIP 2A W/DIODE 5V	1303-7-1	WABSH	175 1507	24
U2 U4 U6	SOCKET IC 14PIN DIP ST	ICN-1143-S3-G	RODNU	353 1403	3
TP1 TP2 TP3 TP4	CONN TERM PIN .025 WW (2END)	W239-025-5000	A/S	354 0007	4

WAVETEK PARTS LIST | TITLE: ASSY. PRE WAVE LOAD 716-0735 | ASSEMBLY NO: 1208-00-2528 | REV: A | PAGE 12

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES | MATERIAL | FINISH WAVETEK PROCESS | DRAWN | DATE | PROJ ENGR | RELEASE APPROV | TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1° XX ± .030 | DO NOT SCALE DWG | SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: PARTS LIST LOW PASS BRICKWALL FILTER

MODEL NO: 716 | DWG NO: 004.0735 | REV: N | CODE IDENT: 23338 | SHEET 2 OF 3

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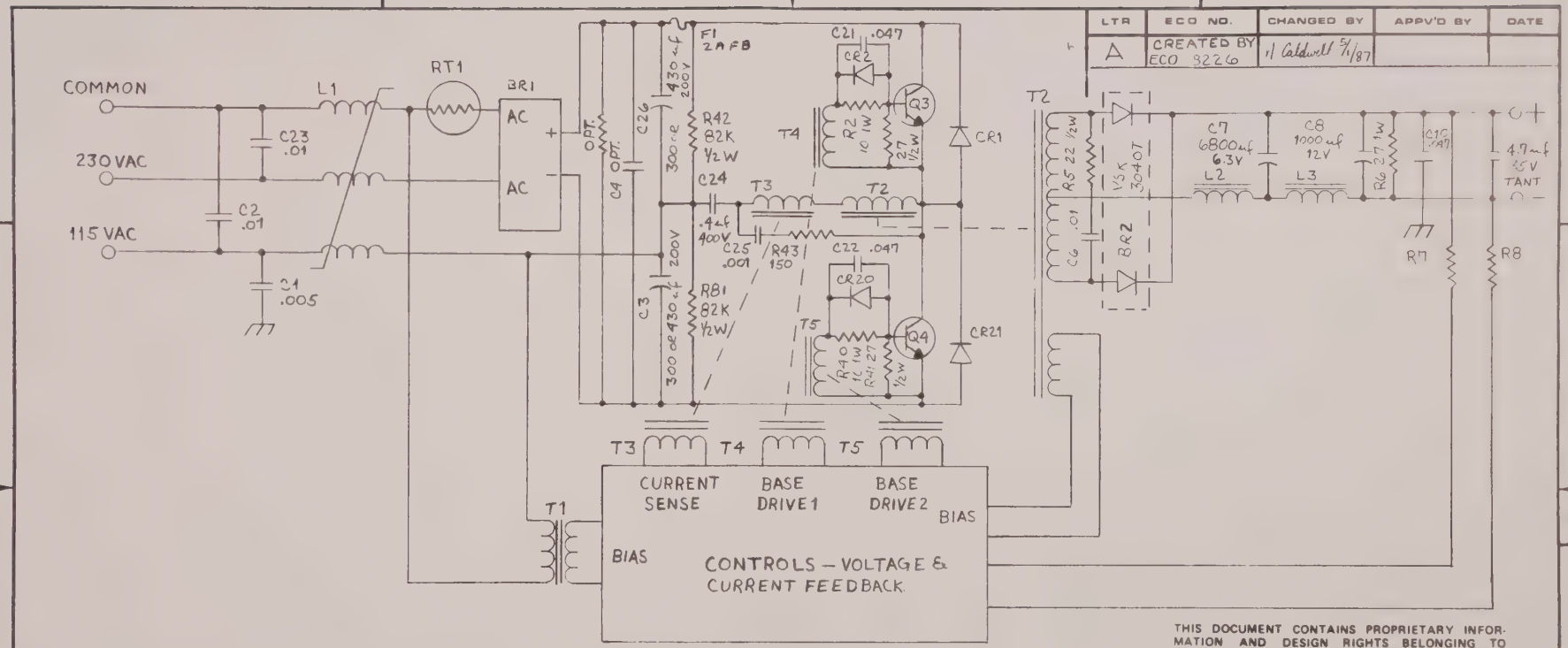
REV	ECN	BY	DATE	APP

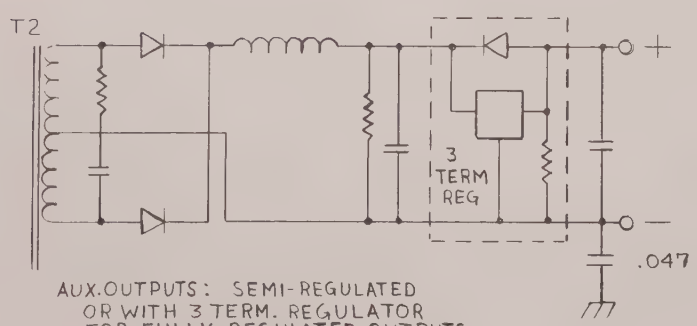
REFERENCE DESIGNATORS	PART DESCRIPTION	DRIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	ELECT SCHEMATIC LOW PASS ELLIP FILTER	03 004 0735	WVTK	03 004 0735	1
U2 U4 U6	U. GD LIN BIFET OP-AMP (LF347)	LF347N	NSC	120. 2047	3
NONE	ASSY, PRE WAVE LOAD 716-0735	716-2528	WVTK	1208-00-2528	1
L3	L FXD 250 UHY HI-CURR	6310-9	CADBU	150. 1251	1
E1 E2 E3 E4 E7	CONN, PLUG SHORTING (LOW PROF)	4612872-01-03-10	CTC	352 0202	5
250	SOCKET JMPR (USE W/352 0202)	4303327-01-0300	CTC	353. 0104	10
254	EJECTOR: PC, 716	NE3001-W	ELEBP	364. 0403	2
256	SPACER, NYL SNAP-BTN (MB1-156)	MB-1-156	PEMC	376. 2109	1
262	WIRE, BUSS TINNED [redacted]	9022	WEICO	378. 0401	2 4
264	SLVNG: PLASTIC FBRGLS #22AWG			378. 3221	2 3

WAVETEK PARTS LIST	TITLE: TOP OPT 716-001, FILTER CARD LOW PASS BRICKWALL	ASSEMBLY NO: 004 0735	REV: N
		PAGE 1	

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN / DATE	WAVETEK SAN DIEGO, CALIFORNIA	
MATERIAL	PROJ ENGR	TITLE: PARTS LIST LOW PASS BRICKWALL FILTER	
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 XX ± .030 ANGLES ± 1°	MODEL NO: 716	DWG NO: 004 0735 REV: N
	DO NOT SCALE DWG	CODE IDENT: 23338	SHEET 3 OF 3
	SCALE		

NOTE UNLESS OTHERWISE SPECIFIED





AUX. OUTPUTS: SEMI-REGULATED OR WITH 3 TERM. REGULATOR FOR FULLY REGULATED OUTPUTS.

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
A	CREATED BY ECO 3226	J Caldwell		5/1/87

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DRAWN BY	TC	DATE 7/16/87
CHECKED BY		
ENG APPVL		7/17/87
MFG APPVL		

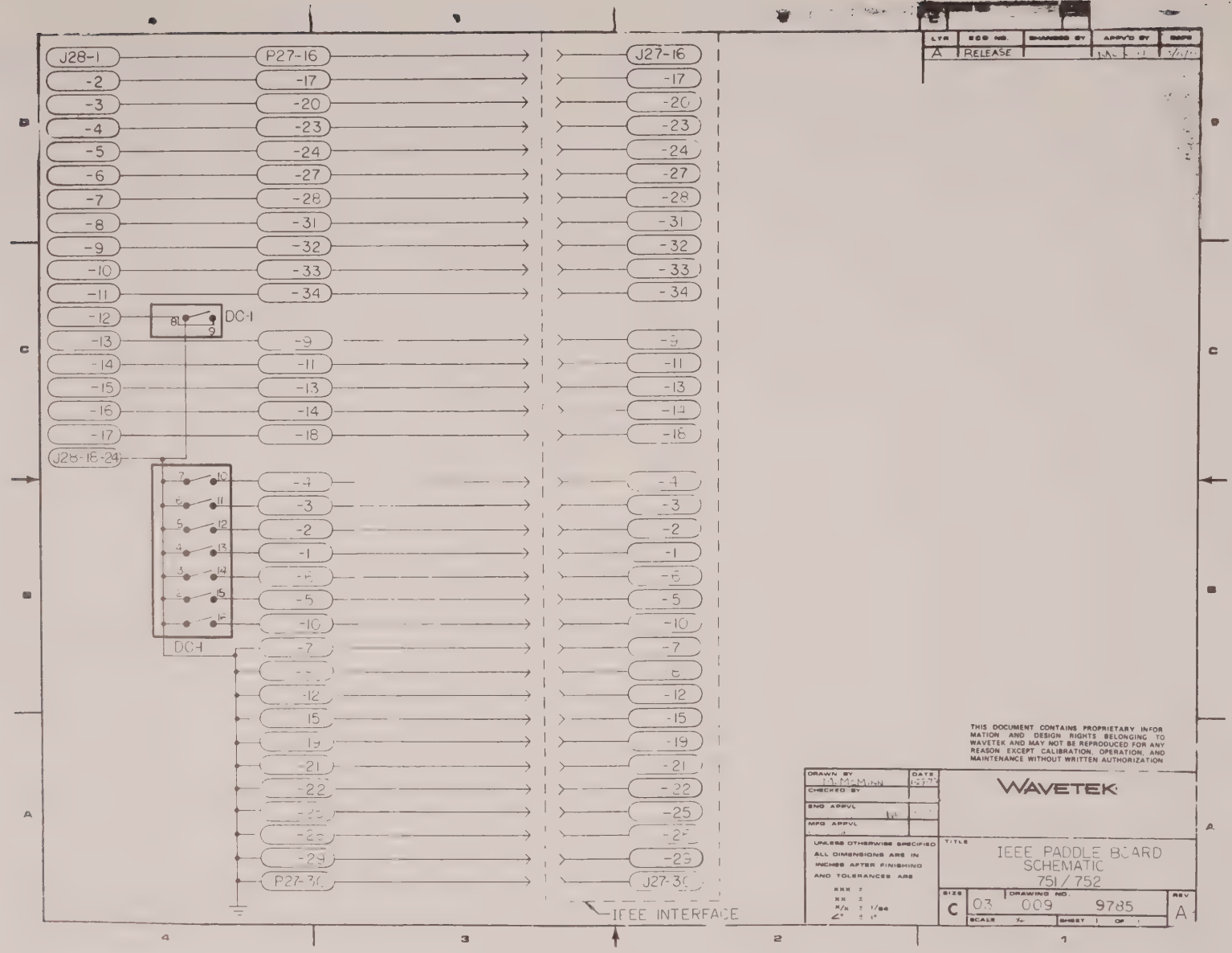
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/x ± 1/64
∠° ± 1°

WAVETEK

TITLE
SCHEMATIC POWER SUPPLY
115 / 230 VAC
(716)

SIZE	DRAWING NO.	REV
B	03 - 174 - 5106	A
	SCALE — SHEET 1 OF 1	

SIZE B DWG NO 03-174-5106 REV A


J28-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
-16
-17
J28-18-24
P27-16
-17
-20
-23
-24
-27
-28
-31
-32
-33
-34
DC-1
-9
-11
-13
-14
-18
DC-4
-4
-3
-2
-1
-5
-10
-7
-12
-15
-19
-21
-22
-25
-29
P27-37
J27-16
-17
-20
-23
-24
-27
-28
-31
-32
-33
-34
-9
-11
-13
-14
-18
-4
-3
-2
-1
-5
-10
-7
-12
-15
-19
-21
-22
-25
-29
J27-37
IEEE INTERFACE
LTR
ECO NO.
CHANGED BY
APPV'D BY
DATE
A
RELEASE
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DRAWN BY
M. McMunn
DATE
CHECKED BY
ENG APPVL
MFG APPVL
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
WAVETEK
TITLE
IEEE PADDLE BOARD
SCHEMATIC
751/752
SIZE
C
DRAWING NO.
03 009 9785
REV
A
SCALE
SHEET 1 OF 1

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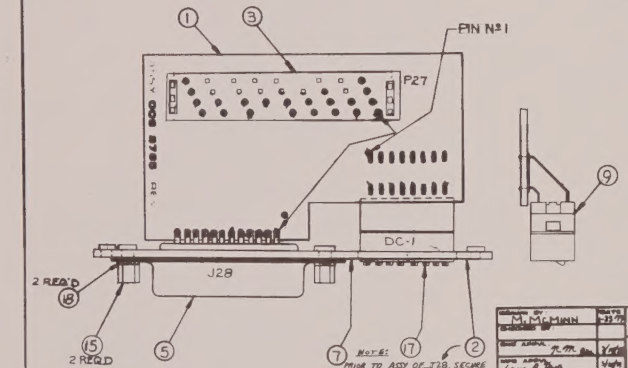
LTR	ECO NO.	CHANGED BY	APPVD BY	DATE
A	RELEASE			
B	1082	JB 12-10-79		
C	1106			


PIN Nº 1
P27
DC-1
J28
2 REQ'D
2 REQ'D
NOTE: MRK TO ASSY OF J28, SECURE LABEL, THE OUTSIDE OF BLACK RECTANGLES MUST BE CUT OUT BEFORE APPLYING TO PANEL. (NO BLACK FROM THE BORDER SHOULD BE SHOWING.)

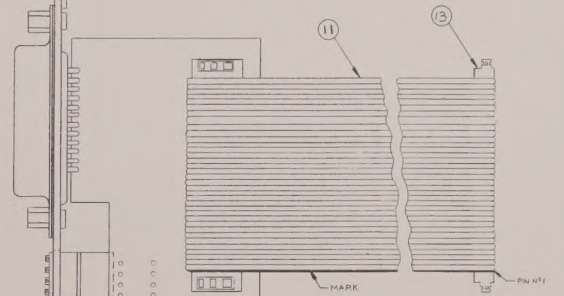
DRAWN BY M. McMINN 1-25-79
CHECKED BY
END APPVL
MFG APPVL
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE .XXX ± .005 .XX ± .01 X/x ± 1/64 ∠° ± 1°

WAVETEK

TITLE: ASSEMBLY IEEE PADDLE BOARD 751/752

SIZE B | 02 009 9785 | REV C | SCALE 2/1

LTR	ECO NO.	CHANGED BY	APPVD BY	DATE
	SEE SHT. Nº 1			



DRAWN BY M. McMINN 1-25-79
CHECKED BY
END APPVL
MFG APPVL
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE .XXX ± .005 .XX ± .01 X/x ± 1/64 ∠° ± 1°

WAVETEK

TITLE: ASSEMBLY IEEE PADDLE BOARD 751/752

SIZE B | 02 009 9785 | REV C | SCALE 2/1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY, PC BD PREPPED 751-2-02-9785	751-2-02-2719	WVTK	1208-00-2719	1
DC1	S. DIP 8 POLE 2 POS	76S808	GRAHL	342.8100	1
J28	CONN: RIB SKT CHASSIS 24 CNT	57-20240-2	AMPH	351.2403	1
NONE	SOCKET IC 16PIN DIP HDR	16-823-90	ARIES	353.1603	1
NONE	SOCKET 34PIN DIL LOCK CLSEND	3414-7034	3M	353.3402	1
NONE	CONN: BD/CABLE 34CONT .050	3402-0000	3M	354.3400	1
NONE	CONN MTG PLATE: IEEE 752/ PIN			371.1015	1
P27	CABLE: 34CND RIB 28GA STR .050	3365/34	3M	370.4018	13
NONE	WASHER: SPLT LK SS #8			388.1082	2
NONE	GUIDE PIN ASSY FEM METRIC	552633-3	AMP	389.7004	2

WAVETEK PARTS LIST

TITLE: CABLE ASSY: IEEE INTERFACE 751

ASSEMBLY NO. 009 9785

REV C

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN
PROJ ENGR
RELEASE APPROV
DATE
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1° XX ± .030
DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: ASSEMBLY/PARTS LIST PADDLE BOARD

MODEL NO 716 | DWG NO 02-009-9785 | REV C

CODE IDENT 23338 | SHEET 1 OF 1

MP MASTER
MA34706